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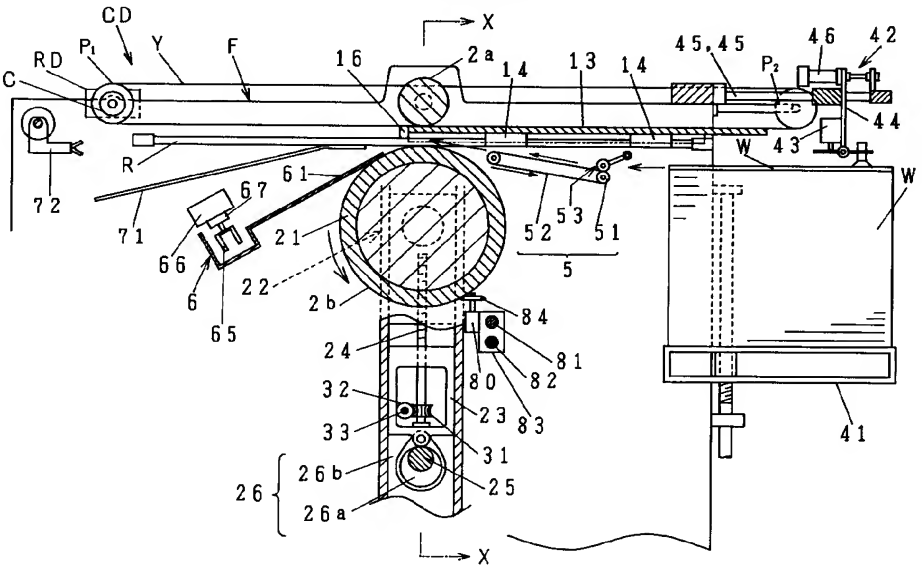
(54) Punching method and punching apparatus.

(57) A punching apparatus punches a sheet of paper into products and a scrap by a flat pattern being implanted with blades of a shape of a product. No prior punching apparatus cannot separate products from a scrap at the time when products have been punched. This invention uses a flat pattern(K) upside down. The flat pattern have closed-loop blades on the bottom surface. The blades shape products. A lower roller (2b) presses a sheet of paper to the blade-implanted bottom surface of the flat pattern. Products are punched out from the sheet by the blades one by one, while the flat pattern progresses and the lower roller rotates. The products are withdrawn from one side of the punching section. The scraps are taken out from the front part of the punching section.

FIG. 6



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This invention relates to a punching method and punching apparatus especially for punching products of a predetermined shape from a sheet of paper by a flat pattern which is a plate having many equivalent blades of the predetermined shape on a surface.

This application claims the priority of Japanese Patent Application No.291729/1992 filed October 29, 1992, which is incorporated herein by reference.

Punching machines of pressing type have been used for punching a plenty of products, e.g. cards from a sheet of paper. The pressing-type punching machine uses a simple flat pattern which has rectangular blade bands implanted on a surface. The cost of production for pattern is inexpensive. The pressing-type punching is preferable for the products with a small number of many versions.

However, the pressing-type punching machine suffers from some drawbacks. First the pressing-type machine requires very strong pressure for punching, because the whole blade-implanted surface is pressed on a sheet of paper at the same time. Second the pressing-type punching demands joints (J) between products (A) and a scrap (S) in order to take out the punched sheet in a body from the punching section of the machine, as shown in Fig.1. Here the scrap (S) is the rest of products of the sheet. The joints (J) are uncut parts between products and the scrap for supporting products temporarily. Individual blades do not form integral closed loops. Each blade has two slits according to the joints in the example of Fig.1. The joints (J) require an extra process of separating the products (A) from the scrap (S) by cutting the joints.

Some trials have been proposed in order to overcome the difficulties; the large pressure and the separation of joints. An apparatus shown in Fig.2 has been proposed for reducing the pressure for punching. The apparatus comprises a flat pattern (K) with a blade-implanted surface (KC) which is driven in a horizontal direction, and a half cylinder press roller (PS) rotatably installed over the blade-implanted surface. The half-roller type machine punches products by the steps of putting a head of a sheet (W) of paper at the front end of the flat pattern (K), driving the half-cylinder press roller (PS) and the flat pattern (K) simultaneously, pressing the sheet (W) from the front end to the rear end between the press roller (PS) and the flat pattern (K), and punching products one by one from the sheet (W). Only the bottom of the half-cylinder roller (PS) presses the sheet at the moment. A small portion of the sheet is cut at the moment. The half-cylinder type allows a punching machine to alleviates the pressure required for punching to a great extent. However, the half-cylinder type cannot solve the other difficulty of joints. This type also needs joints (J) between the products (A) and the scrap (S) for taking out the punched sheet in a body from the punching section. Then the products must be separated from the scrap (S) one by one. The half-cylinder type cannot solve the difficulty of the extra process for separation. Furthermore, the punching is done by the half-cylinder pressing the sheet upon the blade-implanted flat pattern. This apparatus is inapplicable to such a flat pattern longer than the arc length of the half-cylinder. Namely the size of the half-cylinder press roller restricts the lengths of the sheet (W) and the flat pattern (K).

This invention has been originated for overcoming these difficulties. A purpose of this invention is to provide a punching method or a punching apparatus without the joints (J) between products (A) and a scrap (S). Another purpose of this invention is to provide a punching method and punching apparatus with high applicability suitable for various sizes of flat patterns (K).

A punching apparatus of this invention comprises a flat pattern having an upper surface and a lower surface (KC), plural integral, closed-loop blades implanted on the lower surface, a lower roller (2b) equipped below the flat pattern (K) for pressing up a sheet to the lower surface of the flat pattern (K), a driving device either for rotating the lower roller (2b) or for moving the supporting plate (13) in a horizontal direction, a guiding device for guiding the flat pattern (K) along a straight line, and a sheet supplier for supplying sheets of paper between the lower roller and the flat pattern (K), wherein the lower roller rotates and moves the flat pattern along a line with the pressed sheet. This apparatus can treat with both isolated rectangular sheets of paper and a continual, rolled paper band.

The functions of the apparatus will now be explained. The lower roller (2b) presses a front end of a sheet of paper upward to the lower, blade-implanted surface of the flat pattern. Then the lower roller (2b) is rotated. The flat pattern moves in a predetermined direction. The sheet accompanies the flat pattern. A part of the sheet is pressed by the lower roller (2b) against the flat pattern. The rest is free from the pressure from the roller. The position of being pressed transfers from the front end to the rear end of the sheet. The products are punched step by step by the pressure of the lower roller. Not all products are punched at one time. Thus no large pressure is required. A small stable pressure is sufficient for punching a sheet into products. Since the lower roller has a circular section instead of a half-circular section, the apparatus enables the the flat pattern to punch out products from a long isolated sheet or a continual rolled, sheet band. The flat pattern has a plenty of integral, closed-loop blades instead of split

blades. Products are fully punched out from the rest of the sheet. When the lower roller pushes a part of the paper, products are fully cut by the integral blades implanted on the flat pattern. Since the products are entirely isolated from the rest and are supported by nothing, the products fall down from the sheet one by one by the action of gravity. On the contrary, the rest of the sheet is held by the flat pattern and the roller. When all products have been punched and fallen down, the rest which is called a scrap is still kept by the blades of the flat pattern. Then the scrap is taken off and the flat pattern is reset to an initial position either by manual operation or automatic operation. All the parts return to the initial condition. It is preferable to pull down the lower roller prior to the reset of the flat pattern. This is a cycle of punching. Repetitions of the operations will make similar sets of products (A) from new sheets of paper.

The advantages of the invention are now explained. Closed-loop blades of the flat pattern entirely cut products out of the sheet. There need no joints. The flat pattern is used upside down. The sheet is pressed by the lower roller. Thus all products fall down. The scrap is plucked from the flat pattern at the end of the punching. The apparatus can separate products from the scrap automatically without any extra operation. This invention dispenses with the separation process. The lower roller is a simple roller with a circular section. The simple shape of the roller decreases the production cost of the roller in comparison with the half-cylinder of Fig.2. Since the lower roller is a simple circle with an endless circumference surface, the roller can cope with any flat pattern with any length.

Another punching apparatus of this invention comprises a supporting plate which can move in horizontal direction, a flat pattern having an upper surface and a lower surface (KC) and being supported by the supporting plate, plural integral, closed-loop blades implanted on the lower surface, an upper roller rotatably mounted in contact with the upper surface of the supporting plate, a lower roller (2b) equipped below the flat pattern (K) for pressing a sheet against the lower surface of the flat pattern, a driving device either for rotating the lower roller (2b) or for moving the supporting plate in a horizontal direction, a guiding device for guiding the supporting plate along a line, and a paper supplier for supplying sheets of paper or a continual rolled paper band between the lower roller and the flat pattern, wherein the lower roller rotates and moves the flat pattern along a line with the pressed sheet. In the apparatus, the supporting plate can reciprocate in a horizontal direction. The upper roller contacts to the upper surface of the supporting plate. The flat pattern reciprocates in the horizontal direction together with the supporting plate. When the driving device rotates the roller which faces to the blade-implanted, bottom surface of the flat pattern, the blade-implanted surface is moved with the paper by the rotation of the roller or by the displacement of the supporting plate (13). The sheet accompanies the flat pattern. The pressed portion of the paper is cut by the blades of the flat pattern by the pressure given by the lower roller and the upper roller. In the apparatus, the flat pattern with the supporting plate is pressed at the same position by the lower roller and the upper roller. The reciprocal force cancels each other at the contact position. No other external force acts on the flat pattern. The other parts except the contact portion are entirely free from distortion due to external forces. Even if the flat pattern and the supporting plate do not have a sufficient rigidity, the apparatus can apply strong forces to the rollers without deforming the flat pattern. The region on which a big pressure act is narrowly restricted on the flat pattern. Localization of pressure alleviates the total of pressure. Thus this invention succeeds in reducing the size of a punching apparatus.

Other improvements of this invention will now be explained hereafter. One improvement is coating the lower roller with a hard elastic material. Tips of blades pierce the hard, elastic coating partially, which enhances the reliability of cutting. Even if the heights of all blades are not rigorously equal, a sheet can be fully punched without joints. The hard, elastic coating on the roller and the slightly long blades cancel a little fluctuation of the heights of blades.

The coating of the hard, elastic material on the roller is safely replaced by a set of a pressing roller, a side roller and a hard, elastic belt wound with tension around the pressing roller and the side roller.

Another improvement is filling an elastic material, e.g. sponge along the outer surface and the inner surface of the blades implanted on the flat pattern. The elastic material around the blades facilitates the separation of the cut products from the blades.

A third improvement of this invention is further characterized in that sheets of paper are replaced by a long rolled paper, the supporting plate can reciprocate between an initial position in which the front of the supporting plate nearly coincides with the lower roller and a final position which is the forward limit, a lifting device lifts the lower roller up to the blade-implanted surface of the flat pattern, when the supporting plate returns to the initial position, and brings down the lower roller, when the supporting plate reaches the final position, a restoring device returns the supporting plate from the final position to the initial position after the lower

roller has brought down, and a paper supplier replenishes a new paper to the determined position below the blade-implanted surface of the flat pattern. The improvement has advantages of automating all the processes; automatic return of the flat pattern with the supporting plate to the initial position after punching, and automatic replenishment of paper to the punching section between the flat pattern and the lower roller.

A fourth version of this invention is further characterized in that the paper supplier has a suction device which is equipped at the back of the supporting plate for temporarily sustaining the sheet of paper by vacuum and a controller for controlling the suction device either to sustain the paper, when the supporting plate lies at the initial position, or to release the paper, when the supporting plate exists at the final position, and the spot of releasing the paper exceeds the spot of the front of the flat pattern at the initial position. An advantage of the version is an enhancement of the preciseness of determination of the sheet at the supply to the flat pattern, when an individual, separated sheet of a determined size is replenished at the start of the punching cycle. Another advantage of the version is a simplification of the paper supplier.

A fifth version of this invention is characterized in that a paper supplier replenishes a front portion of a continual rolled paper band between the blade-implanted surface of the flat pattern and the lower roller, feeds the paper in accordance with the progress of the flat pattern and stops feeding of the paper when the lower roller descends and separates from the paper. The advantage of the fifth version is a smooth punching action, when a continual paper scroll is punched into products continuously. In this case, the flat pattern must be restored to the initial portion in a condition free from the lower roller, after a cycle of punching processes has finished.

A sixth version of this invention is characterized in that an auxiliary roller is quipped in contact with the lower roller and the lower roller is driven by rotating the auxiliary roller. An advantage of the version is a constant line velocity of the lower roller despite a reduction of diameter of the lower roller due to the wearing down of the surface as long as the line velocity of the auxiliary roller is kept to be constant. The stability of the line velocity maintains the precision of punching for a long time.

The invention will be more fully understood from the following description given by way of example only with reference to the several figures of the accompanying drawings in which,

Fig.1 is a plan view of a sheet with products and a scrap punched by a prior method.

Fig.2 is a sectional view of a punching section of a prior punching apparatus.

Fig.3 is a schematic view of a punching apparatus of this invention.

Fig.4 is a schematic view of a punching apparatus of this invention with a supporting plate having a paper supplier.

Fig.5 is a perspective view of a flat pattern implanted with plenty of rectangular, closed loop band blades.

Fig.6 is a sectional view of a punching apparatus as an embodiment of this invention.

Fig.7 is a sectional view taken along a line X-X in Fig.6.

Fig.8 is a sectional view of the main parts at the initial step of punching.

Fig.9 is a sectional view of the main parts at the intermediate step of the punching.

Fig.10 is a simplified plan view of a punching apparatus as a first embodiment 1.

Fig.11 is a sectional view of a box for storing products.

Fig.12 is a side view of a device for taking scraps out from the punching apparatus.

Fig.13 is a front view of the same device for taking out scraps.

Fig.14 is a front view of a device for refreshing the lower roller.

Fig.15 is a vertically-sectioned view of an apparatus as a second embodiment.

Fig.16 is a front view of a swaying gear for clarifying the action of the gear.

Fig.17 is a sectional view of a lower roller and an upper roller for demonstrating the movement of the parts.

Fig.18 is a simplified sectional view taken along a line Y-Y in Fig.15.

Fig.19 is side view of a suction device for explaining the function thereof.

Fig.20 is a side sectional view of the lower roller and upper roller, when a sheet of paper is replenished into the space between the lower roller and the upper roller.

Fig.21 is a side sectional view of parts of flat pattern, lower roller and a sheet for demonstrating positioning of the front edge of the sheet at the initial position of the flat pattern.

Fig.22 is a schematic side view of a punching apparatus as a third embodiment 3.

Fig.23 is a sectional view of a separation plate, the upper roller, the lower roller, the flat pattern, a sheet, and blades implanted on the flat pattern for exhibiting the action of the separation plate.

Fig.24 is a front view of the separation plate, the flat pattern with blades, a scrap, and products for explaining the action of the separation plate which prevents the scrap from falling down.

Fig.25 is a sectional view of another separation device consisting of a separation plate and a chute for taking a scrap down from products.

Fig.26 is a front view of the separation plate, the flat pattern with blades, a scrap pulled down and products separated from the scrap.

Fig.27 is a perspective view of the flat pattern without sponge between neighboring blades.

Fig.28 is a sectional view of the flat pattern which is driven directly.

To achieve the foregoing objects and in accordance with the purpose of the invention, embodiments will be broadly described herein.

[Embodiment 1]

Embodiment 1 is a punching apparatus of punching all cards from a sheet (W) printed with a set of playing cards and of piling up all the cards in a predetermined order. The rear surface of a flat pattern (K) is implanted with rectangular, closed-loop blades (11) as many as a set of cards. The blades are integral, closed-loop ones without slits, unlike the conventional blades. Details of the apparatus will be now explained.

[Main parts for punching function]

A flat pattern (K) has a base plate (10), rectangular, closed-loop band blades implanted lengthwise and crosswise on the base plate (10) like a matrix, and sponge layers (12) coherent to the base plate with thicknesses thicker than the height of the blades. The sponge layers (12) are divided into two kinds by the blades. Inner sponge layers (12a) are enclosed by the rectangular, closed-loop blades. The number of the inner sponge layers (12a) is equal to the number of the blades (or the cards). An outer sponge layer (12b) covers almost all of the base plate which corresponds to a scrap. However, the forefront of the base plate outside of the blades is not covered with the sponge layer. The inner sponge layer (12a) is thicker than the outer sponge layer (12b). A supporting plate (13) holds the flat pattern (K) on the lower surface. Fig.6 and Fig.7 show the supporting plate (13) reciprocating in a horizontal path between a lower roller (2b) and an upper roller (2a). A frame (F) sustains the lower roller (2b) and the upper roller (2a) in parallel at two different heights. The axes of the rollers (2b) and (2a) lie on the same vertical plane. The supporting plate (13) is retained by four sliders (14) at foreparts and rear parts of the right and left sides. The sliders (14) glide on a pair of horizontal rails (R) and (R) which are upholstered on inner sides of the frame (F).

A horizontal driver (HD) restores the supporting plate (13) to an initial position, after a cycle of punching has finished. The horizontal driver (HD) comprises forward, driving sprockets (P1) rotated by a rotary actuator (RD), rear, free sprockets (P2) and chains (Y) spanning the forward sprockets and rear sprockets. The sprockets (P1) and (P2) are rotatably supported at the forefront and the rear ends of the horizontal parts of the frame (F). The horizontal driver (HD) acts as a restoring device of returning the supporting plate to the initial position.

An output shaft of the rotary actuator (RD) is coupled to the driving sprockets (P1) via a one-way clutch (C). The horizontal driver (HD) is moved freely without resistance to the forward direction because of the one-way clutch. When the supporting plate (13) has reached the final position, the horizontal driver (HD) carries the supporting plate back to the initial position by the action of the rotary actuator.

The upper roller (2a) rolls on the upper surface of the supporting plate (13). The lower roller (2b) is larger than the upper roller (2a). An urethane rubber layer (21) coats the surface of the lower roller (2b). Axes of both sides of the lower roller (2b) are rotatably sustained by bearings (22) and (22) equipped in side vertical ditches of the frame (F). The bearings (22) can ascend and descend, sliding in the side ditches of the frames (F). A pair of sliding blocks (23) and (23) are also upholstered beneath the bearings (22) in the side ditches of the frame (F). The upper bearings (22) are connected to the lower sliding blocks (23) by long adjustable bolts (24). The sliding blocks (23) are coupled via cranks (26) to both ends of an input shaft (25). The input shaft (25) is coupled to a reversible motor (27) with a reduction gear. The crank (26) consists of an eccentric sleeve (26a) and a crank arm (26b). The eccentric sleeve is rotated by the input shaft (25). The crank arm (26b) has an opening into which the eccentric sleeve is rotatably inserted. An end of the crank arm (26b) is connected by a pin to the bottom of the sliding block (23).

When the reversible motor (27) drives the input shaft (25), the sliding blocks (23) reciprocate between the upper dead point and the lower dead point. The bearings (22) also reciprocate in the vertical direction with a definite stroke. Since the same input shaft drives right and left cranks (26) and (26), the right and left bearings (22) and (22) ascend and descend simultaneously in the same phase with the same stroke. Thus the lower roller (2b) also has a lower dead point and an upper dead point in the reciprocal action.

The height of the upper dead point is adjustable for the lower roller (2b). An adjusting device comprises the adjusting bolts (24), worm wheels (31) fixed to the bolts (24), worms (32) mating with the worm wheels (31), a connecting rod for holding two worms (32) near both ends and a handle (34) attached to an end of the connecting rod (33). When an operator turns the handle (34), the connecting rod (33) rotates two worms (32). The

worms turns the adjusting bolts (24) at a reduced speed. Then the bearings (22) go down or go up. Therefore, the level of the lower roller (2b) is adjusted.

The inner wall of the frame (F) has long slots at both ends of the axis of the lower roller (2b) and other long slots at both ends of the connecting rod (33) for allowing the roller (2b) or the rod (33) to reciprocate in the vertical direction. A servomotor (28) is mounted on one of the bearings (22) for rotating the lower roller (2b).

The operations will be explained. The flat pattern (K) with blades and urethane rubber is attached to the bottom surface of the supporting plate (13) upside down. The supporting plate (13) is set to the initial position. A sheet (W) of paper is replenished to the space between the flat pattern (K) and the lower roller (2b) until the forefront of the sheet (W) comes into contact with a stopper (16). The stopper (16) has been mounted at the front of the supporting plate for positioning of sheets. In this condition, the positions of printed cards coincides with the positions of the blades implanted on the flat pattern (K). The reversible motor (27) is driven in a forward rotation. The input shaft (25) rotates in a forward rotation. The lower roller (2b) is raised by the crank (26) till the blades (11) of the flat pattern (K) partially pierce the urethane rubber layer (21) of the lower roller (2b). The depth of penetration of the blades to the urethane rubber can be optimized by varying the level of the lower roller (2b) by turning the handle (34).

Then the servomotor (28) drives the lower roller (2b) in a forward rotation. Since the sheet of paper, the flat pattern (K) and the supporting plate (13) are held in a body between the lower roller and the free-rotating upper roller (2a), the sheet, the flat pattern and the supporting plate progress to the forward direction horizontally. When part of the sheet passes above the lower roller(2b), the blades cut the sheet by the pressing force of the lower roller (2b) and the upper roller (2a). The products separate from the sheet by the elastic force of the inner sponge layers (12a) and fall down by the gravity, as soon as the part has passed by the rollers (2b) and (2a). Since the height of the inner sponge layers (12a) is taller than that of the blade edge in a free state without tension, the inner sponge layers (12a) can expel the cut products entirely out of the blades. On the contrary, the foremost blades are not enclosed by the outer sponge and the forefront of the flat pattern is bare. The rest of products; a scrap (S) is temporarily sustained by the outer surfaces of the foremost blades. The scrap (S) does not fall down.

The products are punched from the sheet one by one according to the progress of the sheet. When the flat pattern as well as the supporting plate reaches the final position, the lower roller (2b) descends by the reverse rotation of a definite angle of the reversible motor (27). The flat pattern (K) becomes free from the pressure of the lower roller (2b). In the condition, the rotary actuator (RD) rotates the sprockets (P1). The backward force is transmitted to the supporting plate (13) via the chains (Y). The supporting plate (13) is restored to the initial position together with the flat pattern (K). The above is the main functions of punching of the apparatus. However, the embodiment includes other devices in addition to the main parts mentioned so far.

[paper supplier]

A paper supplier comprises a rack (41) for piling sheets installed beneath the supporting plate in the initial position, a suction device (42) mounted at the rear end of the supporting plate (13) for sucking only the uppermost one of the piled sheets on the rack (41), an air cylinder (46) for reciprocating the suction device forward or backward in a certain stroke, and a pair of feeders (5) and (5) for feeding the sheet between the flat pattern (K) and the lower roller (2b). The pair of the feeders (5) and (5) are disposed on inner sides of the frame symmetric with each other.

The suction device (42) has a sucker, a lever pivoted at a middle point and holding the sucker on an end, and an actuator (43) swaying the lever at a certain timing. A movable bracket (44) suspends the suction device (42). A pair of horizontal guide bars (45) and (45) slidably sustain the movable bracket (44). An air cylinder (46) pushes forward or pulls back the movable bracket (44) horizontally along the guide bars (45). The timing of the suction by the sucker is determined by the actions of the actuator (43) and the air cylinder (46). First the sucker sucks up the uppermost sheet (W) on the pile. The actuator (43) sways the lever with the sucker. The rear end of the sheet is pulled up. Then the air cylinder (46) transfers the uppermost sheet forward by a certain stroke.

When a determined number of sheets have been removed out of the rack (41), it is raised by a certain distance which is equal to the thickness of the removed sheets. Thus the level of the uppermost sheet exists within a narrow range from the predetermined height.

The feeders (5) and (5) have pairs of front and rear pulleys (51), a pair of belts (52) spanning the pulleys (51), and a pair of pressing rollers (53) in contact with the belts (52). The extension of the progressing belts (52) circumscribes the upper periphery of the lower roller (2b) and collides with the stopper (16) of the supporting plate (13) lying at the initial position.

The pressing roller (53) consists of a free roller and a swaying arm pivoted at a point for sustaining the free roller. The gravity pushes the free roller upon the belt (52) with a slight force. The rear pulley (51) is rotated by some means. The active pulley (51) drives the belt (52) in the direction designated by the arrow in Fig.6. The extension of the uppermost sheet (W) aims at the contact point between the rear pulley (51) and the pressing roller (53).

Aa soon as the suction device (42) sends the uppermost sheet (W) forward between the pressing rollers (53) and the belts (52), the suction device releases the sheet. Since both sides of the sheet are pulled by the belts (52) together with the pressing rollers (53), the sheet is fed into the space between the lower roller (2b) and the flat pattern (K) till the front of the sheet strikes the stopper (16). The stopper (16) prevents the sheet from progressing further. The sheet slips on the running belt (52). Since the pressing rollers (53) push the sheet to the belt (52) with a small gravity, the sheet slides on the belt (52) with little friction. The lower roller (2b) is raised for punching action, as explained before. The pulleys (51) can either rotate incessantly or rotate only at some intervals. In the latter case, the active pulleys (51) shall begin rotating, when the suction device feeds a sheet (W) and shall finish rotating, when the front of the sheet collides with the stopper (16).

[Piling device of products]

The embodiment punches products (A) of playing cards from the sheets (W) on which pictures of playing cards have been printed in order in four lines. Fig.10 demonstrates the piling device of products. Individual pictures of cards are predetermined by the order of piling in the device. The last picture of the most left line is the picture of the card which will be the uppermost card in the piled state in the device. On the contrary, the first picture of the most right will be the lowest card in the piled state. In a line of pictures on a sheet, the cut cards will be piled in the order from the front card to the last card. The nearest former picture of a reference picture of any line will become the nearest card under the reference card. The cards belonging to a line form a group in the piled state. The right neighboring group will be piled directly under the left neighboring group. Thus if we call the most right line of cards the first group, the next most right the second group, the next most left the third group and the most left the fourth group, the first to the forth groups will be piled from the bottom to the top in the order. Namely, the first group will be stored at the bottom, the fourth group will be laid at the top.

As shown in Fig.6, a forwardly inclining chute (61) is mounted in front of the lower roller (2b). The rear end of the chute (61) circumscribes the forward surface of the lower roller (2b). The breadth of the chute (61) is nearly equal to the width of the lower roller (2b). The box (6) for storing products is equipped at the front end of the chute (61).

As the section in Fig.6 clarifies the structure of the box (6), the box has a front wall, a bottom wall and the rear wall. There is no upper wall. The upper side is open for receiving products. The rear wall of the box (6) joins the front end of the chute (61). The inner distance between the front wall and the rear wall is slightly wider than the width of products. The bottom wall inclines forward. Fig.11 shows the section of the box (6) in the vertical direction perpendicular to the progress of sheet. The box (6) has four partial cavities (6a), (6b), (6c) and (6d) from the left to the right in Fig.11. Individual cavity comprises a shorter left-up, right-down slant and a longer left-down, right-up slant. The section seems like a saw due to the series of the slants. The right side is an open side for taking off the products. Two parallel slits (64) and (64) are cut in the bottom wall in the horizontal direction perpendicular to the progress of sheets. A fork (65) having a pair of claws is coupled to an output (67) of a transferring device (66). The fork (65) inserts the two claws into two slits (64) of the box (6). The transferring device (66) reciprocates the fork (65) in the horizontal direction perpendicular to the progress. The fork (65) carries out the products temporarily stored in the cavities (6a), (6b), (6c) and (6d) in series from the left to the right. The right open side of the box (6) leads to a conveyer (68).

When a series of punching actions has finished, piles of cards are stored on individual cavities (6a) to (6d). Then the transferring device (66) moves the fork (65) from the left to the right. The claws carry four partial piles of products toward the left in series. The fourth group (most left) on the cavity (6a) rides on the third group on the cavity (6b). Then the fourth and the third groups heap on the second group on the cavity (6c). Finally, the fourth, third and second groups pile upon the first group of products by the action of the transferring device (66). The four groups are carried further by the conveyer (68).

The actions of the piling device of products must be associated with the actions of punching. The relation between the piling device and the punching device will now be explained here.

The lower roller (2b) rotates counterclockwise in Fig.8 and Fig.9. The flat pattern (K), the supporting plate (13) and a sheet (W) move to the left with the same line velocity as the lower roller (2b). Playing cards as the products (A) are punched

away on the sheet (W) by the blades implanted on the flat pattern (K). The sponge layers push the punched cards down out of the blades. The playing cards (A) fall down on the chute (61). The cards slide in four lines on the chute (61) and drop to the cavities (6a) to (6d) of the box (6) in sequence. As already explained before, the breadth of the box is nearly equal to the width of the lower roller (2b) and the box (6) has four cavities with the same spacing as the groups of pictures printed on the sheet (W). The cards of pictures printed in a line drop in the corresponding cavity in sequence. The first one is piled at the bottom. The following cards heap on the card in order. The last one is piled at the top. When all pictures have been punched out of the scrap, all the cards are piled on the cavities in the order in which the last cards are laid at the top of the heaps.

Then the transferring device (66) moves the fork (65) from the left to the right. Claws of the fork (65) push the piled groups of cards in a body to the right. The moderate slants of the walls and the claws bring the groups of cards on the nearest right groups. When the fork (65) reaches the most right final position, four groups of cards have been heaped into a pile in the order which has been predetermined.

The embodiment feeds a sheet with a printed surface upside to the flat pattern. Namely, the pictures face the blade-implanted surface of the flat pattern (K). Thus the cards fall with a picture upside to the cavities. The cards are heaped in sequence with pictured upsides, after they have been carried out of the conveyer (68).

[Scrap eliminating device]

When products (A) have been punched and have been separated from a sheet, the rest is a lattice-like part. The rest is called a scrap (S). A scrap eliminating device is furnished in the embodiment in order to remove the scrap (S). The scrap eliminating device comprises a scrap guide (71), a pair of clamps (72) and scrap hangers. The scrap guide is upholstered in front of the chute (61). The clamps (72) hold front ends of a scrap, when the flat pattern (K) and the supporting plate (13) are conveyed to the most forward spot by the lower roller (2b). The scrap hanger has two arms (73) and (73) slantingly extending forward and backward symmetrically from a horizontal bar (74). The arms (73) pierce openings (SK) of scraps (S) and hold scraps (S) in sequence.

The scrap hanger consists of a base (B), a shaft (75) vertically standing on the base, a horizontal bar (74) mounted on the top of the shaft (75) and a pair of symmetric arms (73). The shaft (75) can rotate around a vertical axis of the base (B). One of the arms (73) always faces the scrap guide (71).

As a sheet is being punched, the scrap (S) progresses in the state wherein the front side part is fitted on the outside of blades and the rear part is excluded out of the blades by the sponge and is sustained by the scrap guide (71). When the whole of the flat pattern (K) and the supporting plate (13) reach the foremost position and all products have been punched away, the front end of the scrap (S) which has temporarily retained by the blades is gripped by the clamps (72). The rear end of the scrap (S) is loosely sustained by the scrap guide (71). Then the clamps (72) sway lower, as shown by double-dotted line. The scrap (S) separates from the blades at the front and leaves from the scrap guide (71) at the rear. The scrap (S) rotates clockwise in Fig.12, as the back of the scrap falls. Some openings (SK) of the scrap are pierced by the arms (73). The clamps (72) let the scrap (S) go. The scrap (S) falls slantingly along the arms (73). Scraps are hanged on the arms in sequence. As the punching proceeds, the scraps are stored on the arms (73) as shown by double-dotted lines. When the arms of one side are filled with scraps (S), the shaft (75) is rotated half round in order to let vacant arms face to the scrap guide (71). The hanged scraps (S) can be got off from the arms (73) in a pile. The piled state of scraps facilitates binding of the group of scraps. The scrap guide (71) ensures the separation of scrap(S) from the products. In order to heighten the action of separation, the rear end of the scrap guide (71) must be furnished at the falling region of products.

[Refreshing device of the surface of the lower roller]

The embodiment utilizes the lower roller (2b) with a surface coated with an urethane rubber layer (21). The blades cut part of the surface of the urethane rubber. Punching incurs scars on the urethane rubber layer (21). A refreshing device of the surface is furnished below the lower roller (2b) in order to revive the surface of the roller (2b) by eliminating the scars from the surface. The refreshing device comprises a feeding screw (81), a guide shaft (82), a moving block (83) and a rotary blade (84), as shown in Fig.6 and Fig.14. The feeding screw (81) and the guide shaft (82) are parallel with the lower roller (2b) and are furnished between side walls of the frame (F). The moving block (83) has two holes. One is pierced by the guide shaft (82). The other is a screwed hole penetrated by the feeding screw (81). Thus the guide shaft and the feeding screw (81) support the moving block (83) along a horizontal line. The moving block (83) is moved by the feeding screw (81) right and left

along the guide shaft (82). A finishing tool (80) is mounted on the moving block (83). The rotary blade (84) is supported by the finishing tool (80). The height of the finishing tool (80) can be changed at two spots. At the higher spot, the rotary blade (84) comes in contact with the surface of the lower roller (2b). At the lower spot, the rotary blade (84) separates from the lower roller (2b).

Refreshing of the surface of the lower roller (2b) is done by the steps of raising the finishing tool (80) till the rotary blade (84) becomes in contact with the urethane rubber surface of the roller (2b), rotating the lower roller (2b), rotating the rotary blade (84), and rotating the feeding screw (81). The rotation of the feeding screw (81) moves the finishing tool (80) along the surface of the urethane rubber (21). The rotation of the rotary blade (84) abrades the surface of urethane and eliminates the scars or scratches from the surface. Thus the urethane rubber is refreshed along the line. The rotation of the lower roller (2b) ensures overall refreshment of the surface. Preparatory adjustment should determine favorable values of the parameters; the velocity of the moving block (83), the time of reciprocating the moving block (83), and the angular velocity of the lower roller (2b). When the urethane surface has been revived, the moving block (83) is returned to the initial position and the finishing tool (80) is lowered to the initial, rest spot.

[EMBODIMENT 2]

Fig.15 to Fig.20 show another embodiment which automates the steps of feeding sheets, punching products and withdrawing the products in sequence. The embodiment punches products by pressing the sheet on the lower roller (2b) by the blade-implanted surface (KC) of the flat pattern (K), conveys the products (A) and (A) from the chute (61) by the conveyer (68) to the product stock position.

The upper roller (2a) and the lower roller (2b) are raised or lowered at a predetermined timing by the cooperation of a cam (92) and a link device connected to the output shaft (91) of the motor (9). The cam (92) has a bigger part (92a) which has a wider radius and a smaller part (92b) which has a narrower radius. The timing of going up and down of the rollers is determined by the position and the length of the partial arc of the bigger part (92a) on the cam (92). A swaying gear (93) and a crank device are furnished to reciprocate the supporting plate (13). The rotation of the motor (9) is converted to a reciprocal movement by the crank device. The crank device reciprocally rotates the swaying gear (93) around a pivot. The rotation of the motor (9) is transmitted from the output shaft (91) of the motor (9) to the crank (91a). The swaying gear is connected by two parallel bars to a hub rotatably supported by the pivot. The parallel bars pierce holes of a slider (93a). The slider (93a) can slide along the bars. The crank (91a) is retained by a hole of the slider (93a). When the motor (9) rotates the crank (91a), the slider (93a) moves, drawing a circle. Then the bars incline to the right and to the left. The swaying gear (93) accompanies the bars. An intermediate gear (94) is rotated by the swaying gear (93) clockwise or counterclockwise. The mentioned horizontal driver (HD) is connected to the intermediate gear (94). Then the horizontal driver (HD) moves the supporting plate (13) forward or backward.

The horizontal driver (HD) has a similar structure to the HD of embodiment 1. A pair of endless chains (Y) are connected to portions of both sides of the supporting plate (13). The chains (Y) span front sprockets (P2) and rear sprockets (P1). The rear sprockets (P1) are driven by the other sprockets fixed to the intermediate gear (94). In Fig.15, if the swaying gear (93) is moved to the left as shown by a solid-line arrow, the supporting plate (13) goes forward to the left. On the contrary, if the swaying gear (93) is driven to the right as exhibited by a dotted arrow, the supporting plate (13) returns back to the right.

A pair of swinging arms (95) support the shaft of lower roller (2b) at both sides. There is a fulcrum (95a) of the swinging arm (95) in front of the lower roller (2b), namely on the opposite side of the cam (92). The swinging arm (95) has a short free end on the reverse side of the roller (2b). Another pair of swinging arms (96) support the shaft of the upper roller (2a). A fulcrum (96a) of the upper swinging arm (96) lies behind the upper roller (2a). Links (97) couple the free front ends of the lower swinging arms (95) and front tips of the upper swinging arms (96), allowing the arms (95) and (96) to rotate relatively. An input end (98) of the lower arms (95) is in contact with the cam (92). When the input end (98) is raised by the cam (92), the lower roller (2b) is lifted and the free ends of the arms (95) pull down the link (97). The upper arms (96) sink. The upper roller (2a) descends on the supporting plate (13). When the cam (92) contacts with the input end (98) on the lower surface, the lower arms (95) fall and the upper arms (96) rise. The upper roller (2a) separates from the supporting plate (13) and the lower roller (2b) separates from the flat pattern (K). The rotation of the cam (92) makes the lower roller (2b) and the upper roller (2a) either approach or separate. This embodiment determines the upper position of the lower roller (2b) to a height at which the blades of the flat pattern (K) slightly pierce the surface of the lower roller (2b). When the blades prick the lower roller (2b), the upper roller (2a) is in contact with the supporting plate

(13). The swinging arms (95) and (96), the swaying gear, the cam (92), the link (97) and the horizontal driver (HD) are furnished in mechanical boxes (90) and (90) equipped in the side walls of the frame (F). As mentioned before, the upper roller (2a) and the lower roller (2b) are supported at both sides by swinging arms (96) and (95). Right and left swinging arms have the common fulcrums. Common shafts connect right and left sprockets (P1) and (p2) of the horizontal driver (HD).

This embodiment employs a lower roller driver consisting of a driving roller (2c), a pair of swinging levers (R), and an air cylinder (E). The swing levers (R) retain both ends of the driving roller (2c). The driving roller (2c) is coupled with the intermediate gear (94) by a chain and sprockets. A cylinder rod of the air cylinder (E) is connected to the lever (R) for swinging the levers (R). When the cylinder rod of the air cylinder (E) projects, the driving roller (2c) presses the lower roller (2b). Rotation is transmitted from the driving roller (2c) to the lower roller (2b) by the friction force between the rollers (2c) and (2b). Since the driving roller (2c) is rotated by the swaying gear (93), the lower roller (2b) rotates. The line velocity of the lower roller (2b) is equal to the line velocity of the driving roller (2c), because the surfaces of the rollers contact each other. When the lower roller (2b) is revived by grinding the surface for eliminating the scars, the diameter of the roller (2b) diminishes. The line velocity which is important to synchronize the actions does not change regardless of the reduction of the diameter.

This embodiment furnishes a suction device (42) at the rear end of the supporting plate (13) for supplying sheets (W) as shown in Fig.15 and Fig.19. The suction device (42) comprises a sucker (47), a lever (48) and a driving device (43). The sucker (47) is held by the lever (48). The driving device (43) lifts or sinks the lever at a predetermined timing. When the supporting plate (13) lies at the initial position, i.e. most backward position, the sucker (47) sucks and lifts the front end of the uppermost sheet piled on the rack(41). While the supporting plate progresses in accordance with the punching function, the suction device carries the sheet to the upper surface of the lower roller (2b), accompanying the supporting plate. When the supporting plate (13) attains the final position, i.e. the most forward position, the sucker (47) releases the sheet. The front end of the sheet falls on the upper surface of the lower roller (2b). The rear end has been loosely supported by an intermediate tray (5a). The rest position of the front end of the sheet is further advanced than the position of the stopper (16) of the supporting plate (13) at the initial position. Accordingly, while the supporting plate (13) is retreated by the horizontal driver (HD) to the initial position, the stopper (16) collides with the front end of the sheet temporarily lying on the roller (2b) and the tray (5a). The sheet is slightly pushed backward by a certain length. When the supporting plate (13) has been reverted to the initial position, the sheet is precisely positioned at a determined spot by the stopper (16). The precision of positioning of the sheet (W) is enhanced by the twice movements of sheet, i.e. the forward conveyance by the suction device and the backward displacement by the stopper.

In the embodiment, scraps are disposed by a rotary cutter (77) upholstered in front of the upper roller (2a) and the lower roller (2b). The lower roller (2b) and the flat pattern (K) send a scrap (S) forward, while the sheet is being punched. When the punching has finished, the scrap (S) is transferred to a belt conveyer (78). The belt conveyer (78) feeds the scrap (S) into the rotary cutter (77). The scrap (S) is cut into many small pieces.

The functions of embodiment 2 will be explained.

The motor (9) is driven. The swaying gear (93) rotates counterclockwise as shown by the solid line arrow in Fig.15. The cam (92) rotates. The bigger part (92a) of the cam (92) raises the input end (98) of the swinging arms (95). The lower roller (2b) lifts the lower roller (2b) to the bottom surface of the sheet. At the same time, the upper roller (2a) sinks on the supporting plate (13) by the action of the link (97). The air cylinder (E) pushes driving roller (2c) to the surface of the lower roller (2b). The lower roller (2b) is rotated by the driving roller (2c). The torque is transmitted by the friction between the driving roller (2c) and the lower roller (2b). Since the blades of the flat pattern (K) pierce the surface of the lower roller (2b) in the state, the supporting plate (13) as well as the flat pattern (K) progresses without slippage, accompanying the lower roller (2b). In this embodiment, the supporting plate (13) is also driven by the horizontal driver (HD) coupled to the motor (9). Thus the supporting plate (13) is driven by two mechanisms synchronously.

Then the punching action begins. As the lower roller (2b) is lifted, the suction device sucks up the uppermost sheet (W) of a certain size heaped on the box (41) at the same time. While the punching action proceeds, the sheet is carried through the punching section by the suction device accompanying the supporting plate (13). When the whole area of the sheet has been punched, the input end (98) of the swaying arm (95) rolls down from the bigger part (92a) to the smaller part (92b). The lower roller (2b) sinks and separates from the sheet, as shown in Fig.20. The upper roller (2a) rises a little from the supporting plate (13). The final position of the supporting plate (13) is predetermined to a spot slightly preceding the position

at the end of punching by adjusting the relation between the swaying gear (93) and the horizontal driver (HD). When the supporting plate (13) reaches the final position, the sheet (W) carried by the suction device lies at a spot slightly advancing from the position of sheet at the beginning of punching. Then the sucker releases the sheet. The sheet (W) is temporarily sustained by the tray (5a) and the lower roller (2b).

The swaying gear begins to rotate in the reverse direction. The air cylinder (E) pulls back the rod. The driving roller (2c) separates from the lower roller (2b). The horizontal driver (HD) reverts the supporting plate (13) to the initial position. Since the supporting plate (13) and the flat pattern (K) are free from the rollers (2b) and (2a), the supporting plate (13) can be retreated with a small force. While the supporting plate (13) is going back, the stopper (16) collides with the front of the sheet and puts a little the sheet backward. When the supporting plate (13) attains the initial position, the position of the sheet (W) precisely coincides with the position of the flat pattern (K). This is a cycle of punching. Then a sequences of punching will be repeated by the rotation of the motor (9). Sheets piled on the rack (41) are fed into the punching section and punched into products (A) one by one.

[EMBODIMENT 3]

Both embodiments 1 and 2 punch products (A) from independent, isolated sheets (W) of a predetermined size. This invention can be also applied to an apparatus of punching continual paper wound in a roll. Here another embodiment for continual paper will be explained now by referring Fig.22. The version of the invention can also adopt the same punching device as embodiment 1 or embodiment 2. However, embodiment 3 employs another punching device. The punching device includes a pressing roller (20), a side roller (2d) and an urethane rubber endless belt (V). The urethane rubber belt (V) circulates the pressing roller (20) and the side roller (2d). The belt replaces the urethane rubber coating of the lower roller of embodiments 1 and 2. When the pressing roller (20) is raised, the blades (11) of the flat pattern (K) a bit pierce the surface of the urethane rubber belt (V) through the paper for ensuring cutting of paper. Besides the function, the urethane rubber belt (V) has another new role as a device for taking out products.

L2 is a feeding roll of new continual paper wound in many turns. The continual paper has been already printed with many figures at certain distances both in the longitudinal direction and the transverse direction. L1 is a withdrawing roll of scrap. The paper wound off from the feeding roll (L2) passes through the space between the blades of the flat pattern (K) and the urethane rubber belt (V) on the pressing roller (20), goes back and is wound up into the withdrawing roll (L1). The paper is punched by the blades during progression on the pressing roller (20). The paper advances as scrap from the lower roller to the withdrawing scrap roll (L1). The withdrawing roll (L1) is always rotated by a weak torque. A free roller (L3) bends the continual paper in front of the withdrawing roll (L1). The free roller (L3) is supported by an arm pivoted at a point and pulled down by an elastic device. Tension of the paper balances with the elastic force. The fluctuation of the speed of the paper is absorbed by the free roller (L3). The material paper is pulled out from the feeding roll (L2) by a pair of extracting rolls (55) whose line velocity is determined to be equal or nearly equal to the punching velocity. Normal case demands the equality of the velocities. However, when the material paper has a bit shrunk in the longitudinal direction, the feeding velocity should be slightly slower than the punching velocity. The paper meanders through several rollers. Another free roller (L4) elastically pulls down the paper in order to absorb the fluctuation of the feeding speed.

The upper roller (2a) and the supporting plate (13) are rotated and carried by a chain which is driven by a servomotor (56). The carrying speed by the servomotor (56) balances with the feeding velocity of paper by the extracting roller (55).

The punching function will be explained. At first the supporting plate (13) lies at the initial position, i.e. the most right position in Fig. 20. The pressing roller (20) is distanced from the flat pattern (K), as shown in Fig. 20. Then the pressing roller (20) is pushed up till it becomes in contact with the flat pattern (K). A part of the continual paper is sandwiched between the urethane rubber and the flat pattern (K). As the pressing roller (20) rotates, the flat pattern (K) and the paper make their ways forward. The servomotor (56) drives the supporting plate (13) synchronously. The extracting roller (55) feeds paper to the pressing roller (20) at the same velocity. The blades of the flat pattern punch products (A) one by one from the paper in accordance with the progress of the paper. The products (A) fall on the urethane rubber belt (V). The punched paper, i.e. scrap (S) is wound up by the withdrawing roll (L1). After all products have been punched away from the paper, the supporting plate (13) attains the final position, i.e. the most left position in Fig.20. The pressing roller (20) sinks and separates from the flat pattern (K). The extracting roller (55) stops feeding of the paper. The paper is at rest on the punching section. But winding up of the scrap continues at the withdrawing roll (L1). The free roller (L3) rises for enabling the withdrawing

roll (L1) to wind up the scrap at a constant speed. Then the servomotor (56) brings back the supporting plate (13) to the initial position by a counterclockwise circulation of the chain. This is one cycle of punching operation.

Another cycle of punching starts. The pressing roller (20) is lifted up. Another part of the paper is held between the pressing roller (20) and the flat pattern (K). The extracting roller (55) begins to feed the paper to the flat pattern (K). The feeding roll (L2) starts winding off. The next punching operation will be done. Feeding of paper proceeds intermittently, synchronizing with the punching operation. But winding up of scrap is continuous. One punching winds off a unit length of paper from the feeding roll (L2) and winds up a unit length of scrap to the withdrawing roll (L1). Embodiment 3 is suitable for continual, band paper wound around a roll. An advantage is a facile treatment of scrap, because the scrap paper is wound up to the withdrawing roll (L1). Another advantage is a simple feed of paper to the punching section, because continual paper is carried by rollers. Another good point is easy synchronization between feeding and punching. The other advantage is a reliable takeout of products by the belt (V).

Of course withdrawal of scrap can be done intermittently too, synchronizing with punching. Another version of the invention introduces an intermittent feed of paper by furnishing a brake (not shown in figures) for stopping the feed of paper, while the supporting plate is retreated from the final spot to the initial spot. The coupling of the pressing roller (20), the side roller (2d) and the belt (V) can be replaced by a single roller coated with urethane rubber as embodiment 1 or 2.

Other types of devices are also available for separating products and scrap. Embodiment 1 separates a scrap from products by the rear end of the scrap guide (71) furnished before the lower roller (2b). The height of the rear end is slightly lower than the level of the paper sheet being punched. The following improvement ensures the separation of products from a scrap. Fig.23 and Fig. 24 demonstrate separation plates (SE) provided in front of the roller (2b) for separating the scrap from products. The separation plate is a key-shaped or triangle plate. The separation plates are vertically installed at the extra, outer spaces between neighboring blades, as shown in Fig.24. The extra, outer space means the space which is included within the scope of a sheet but is outside all the closed-loop blades. Namely, the extra, outer space corresponds to the longitudinal lines of the scrap. The separation plates are fixed on the chute (61) with sharp edges facing the punching section. The separation plates are all parallel with a common plumb plane which is perpendicular to the direction of axes of the rollers (2b) and (2a). The edges of the separation plates divide a scrap from products. When a scrap and products advance from the punching section to the separation plates (SE), the tip of the scrap (S) is scooped up upon the separation plates (SE). Then the scrap slides forward and goes out. On the contrary, the products are pushed down by the sponge layer buried in the closed-loop blades, and are separated from the scrap (S). The products fall on the chute (61) between neighboring separation plates (SE). Besides the separation from the scrap, the separation plates have another role of separating the products from other lines. Separation of products into lines facilitates accumulation of products in sequence.

Embodiments 1 and 2 exhaust scraps from an outlet above the exit of products. The scraps are accumulated on some place. Then the pile of scraps often disturbs taking up the products falling from the punching section. An improvement shown by Fig.25 to Fig.27 will solve the difficulty of gathering products. In the version, no sponge layer is furnished outside of all closed-loop blades. Only inner regions of closed-loop blades are coated with sponge as shown in Fig.27. Key-shaped separation plates are mounted on the chute (61). The sharp edges of separation plates face the punching section. The separation plates have arcs on the lower sides along the periphery of the lower roller (2b). The separation plates correspond to the outer regions between neighboring closed-loop blades (11) and (11). There are narrow gaps between the arc sides and the surface of the lower roller. The edges of the separation plates push down scraps. The scrap progresses in the gap between the lower roller and the arc sides of the separation plate. In the apparatus of Fig.25 and Fig.26, when blades punch products from a sheet, the products are repelled by the sponge layer out of the blades. The products fall on the chute (61). Sliding on the chute (61), the products again fall and pile on a product accumulator. The scrap (S) is generated between neighboring closed-loop blades and is separated by the separation plate (SE). The separated scrap passes through the narrow gap between the lower roller and the separation plate, and piles on the scrap accumulator installed below the chute (61). The piled scraps do not disturb taking out of products. This improvement solves the difficulty of pulling out of products.

In the embodiments mentioned, the lower roller (2b) drives the supporting plate and the flat pattern forward. However, a reverse driving is available. The alternative will have a free-rotating lower roller (2b) and a driving supporting plate. In the case, the lower roller has no driving device. Since the lower roller does not positively move the flat pattern as well as the supporting plate, the line velocity is

kept constant despite diminishing of diameter of the roller. In the version, as shown in Fig.28, metal cramps (15) should be provided on both sides of the supporting plate (13). The cramps hold the flat pattern (K). The bottom of the cramps should be the same level as the tips of blades in order to assure friction force between the supporting plate and the lower roller (2b). Since the lower roller is a free roller, torque must be transmitted from the supporting plate to the lower roller by some means for rotating the lower roller at the same line velocity as the horizontal driver (HD). Of course the blades can transmit rotation to the lower roller, because the tips of the blades pierce the urethane rubber of the lower roller (2b). However, when the blades are parallel to the progressing direction, the blades cannot transmit torque, because the blades cut the urethane rubber in the progressing direction. The cramps pull the lower roller forward by the friction. In any phase of rotation, the line velocity of the roller can be precisely commensurate with the supporting plate (13). The level of the bottom surface of the metal cramp (15) may be 0.05 mm to 0.1 mm higher than the level of the tips of the blades (11).

Claims

1. A punching method of punching products from a sheet (W) of paper by pressing the sheet (W) with a flat pattern (K) having blades (11) of a shape of product on a surface comprising the steps of:

   implanting closed-loop blades (11) on a bottom surface of the flat pattern (K),

   furnishing the flat pattern (K) upside down to a horizontal driver (HD) which can reciprocate in a horizontal direction,

   installing a lower roller (2b) below the flat pattern (K),

   returning the flat pattern (K) to an initial position behind the lower roller (2b),

   supplying the sheet (W) of paper to a space between the lower roller (2b) and the flat pattern (K),

   pressing the sheet (W) by the blades (11) on the lower roller (2b),

   rotating the lower roller (2b),

   moving the flat pattern (K) with the lower roller (2b) from the initial position to a final position before the lower roller (2b),

   punching the sheet (W) into products (A) and a scrap (S) by the blades (11), and

   withdrawing the products (A) and taking scraps (S) out.

2. A punching method as claimed in claim 1, wherein after the products (A) have been punched from the sheet (W), the lower roller (2b) is sunk and separated from the flat pattern (K), and the flat pattern (K) is retreated to the initial position.

3. A punching method as claimed in claim 1 or 2, wherein the lower roller (2b) consists of a pressing roller (20) which presses the flat pattern (K), and a hard, elastic belt (V) winding around the pressing roller (20) with tension.

4. A punching apparatus for punching products from a sheet (W) of paper by pressing the sheet (W) with a flat pattern (K) having blades (11) of a shape of product on a surface comprising:

   closed-loop blades (11) of a shape of product,

   a flat pattern (K) having a bottom surface implanted with the blades,

   a supporting plate (13) for holding the flat pattern on a bottom surface,

   a horizontal driver (HD) for sustaining and moving the supporting plate (13) in a horizontal direction,

   a free, upper roller (2a) which can contact with an upper surface of the supporting plate,

   a lower roller (2b) which can press the sheet on the blade-implanted bottom surface of the flat pattern (K) at the same horizontal position, and

   a driver of driving at least one of the lower roller (2b) or the supporting plate (13) for moving the supporting plate in the horizontal direction and rotating the lower roller (2b).

5. A punching apparatus as claimed in claim 4, wherein the lower roller (2b) can be separated from the blades-implanted surface of the flat pattern (K).

6. A punching apparatus as claimed in claim 4 or 5, wherein the lower roller (2b) is coated with a hard, elastic layer, and the blades partly pierce the hard, elastic layer of the lower roller (2b) when the sheet is sandwiched between the lower roller (2b) and the flat pattern (K).

7. A punching apparatus as claimed in claim 4 or 5, wherein the belt (V) winds around the pressing roller (20) and a side roller (2d) with tension.

8. A punching apparatus as claimed in claim 7, wherein the belt (V) winds around the pressing roller (20) and a side roller (2d) with tension.

9. A punching apparatus as claimed in any one of claims 4 to 8, wherein the flat pattern has plural blades (11) with a shape corresponding to the product, and the front end of the base plate outside the blades is not covered with an elastic layer.

10. A punching apparatus as claimed in claim 9, wherein all the elastic layers of the flat pattern are higher than the blades and the elastic layers in the closed-loop blades are higher than the elastic layers outside the blades.

11. A punching apparatus as claimed in claim 9, wherein the flat pattern has plural blades (11) with a shape corresponding to the product, the front end of the base plate outside the blades is not covered with an elastic layer.

12. A punching apparatus as claimed in any one of claims 4 to 11, wherein the supporting plate (13) can reciprocate between an initial position where the front nearly coincides with the lower roller (2b) and a final position, a lower roller lifting device (101) is installed for separating the lower roller from the flat pattern (K) when the supporting plate (13) reaches the final position and for bringing the lower roller (2b) into contact with the blades of the flat pattern (K), a retreating device (102) is furnished for returning the supporting plate from the final position to the initial position, and a paper supplier (103) is equipped for supplying a sheet (W) to a certain position between the flat pattern (K) and the lower roller (2b) when the lower roller lies at a lower height.

13. A punching apparatus as claimed in any one of claims 4 to 12, wherein a separation device is installed at an outlet of the lower roller (2b) for separating products (A) from a scrap (S).

14. A punching apparatus as claimed in claim 13, wherein the separation device is key-shaped separating plates with a sharp edge facing extra spaces between neighboring blades of flat pattern (K), the products are pushed down between neighboring separating plates, and the scrap is pushed up on the separating plates.

15. A punching apparatus as claimed in claim 13, wherein the elastic layer is not coated on longitudinal, extra spaces between neighboring closed-loop blades, the separation device is key-shaped separation plates with a sharp edge facing the extra spaces of the flat pattern (K), and the separating plates push down a scrap and scoop the products up.

16. A punching apparatus as claimed in any one of claims 4 to 9, wherein the material paper is a long, continual paper wound in a roll, the supporting plate can be reciprocated from an initial position at which the front end coincides with the lower roller (2b) and a final position at which the rear end projects forward from the lower roller (2b), a lower roller lifting device is furnished for sinking the lower roller (2b) when the supporting plate (2b) reaches the final position and for lifting the lower roller (2b) when the supporting plate (2b) returns to the initial position, a retreating device is installed for returning the supporting plate to the initial position, and a paper supplier feeds a long, continual paper to a space between the blades (11) and the lower roller (2b) when the lower roller pushes the paper to the roller and stop feeding when the lower roller separates from the flat pattern.

17. A punching apparatus as claimed in any one of claims 4 to 16, wherein the supporting plate (13) has no own driving apparatus, the lower roller is in contact with an auxiliary roller, the auxiliary roller drives the lower roller at a constant speed, and the supporting plate (13) is moved by the lower roller (2b).

18. A punching apparatus as claimed in any one of claims 4 to 16, wherein the lower roller is a free roller, the supporting plate drives the paper and the lower roller, clamps (15) support the flat pattern to the supporting plate, the level of the clamps is nearly equal to the height of the blades of the flat pattern.

FIG. 1

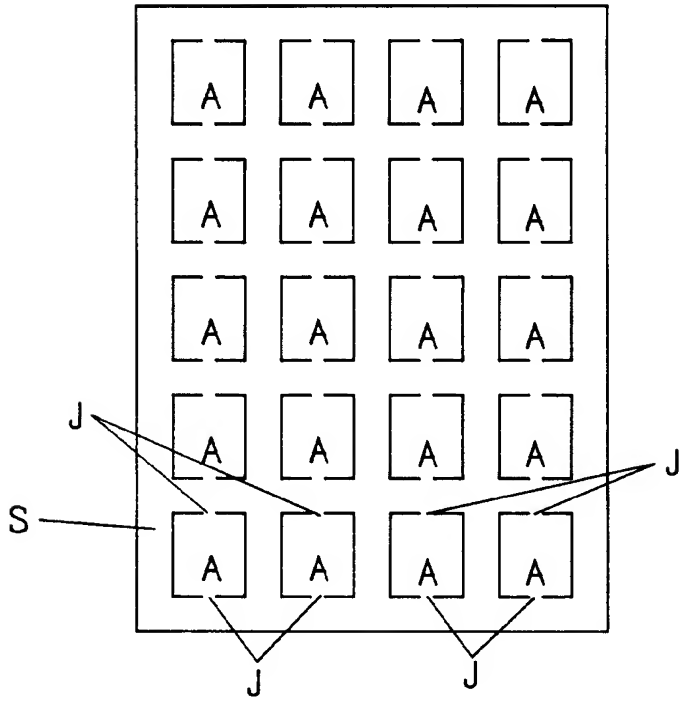


FIG. 2

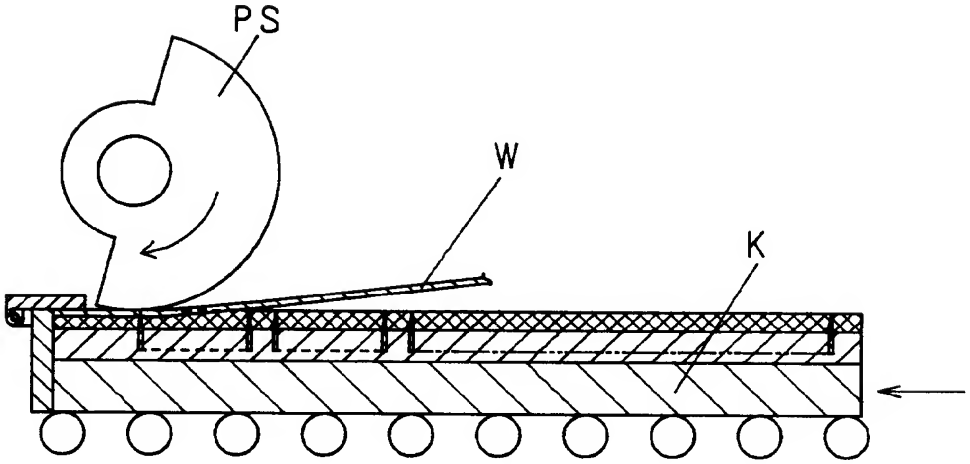


FIG. 3

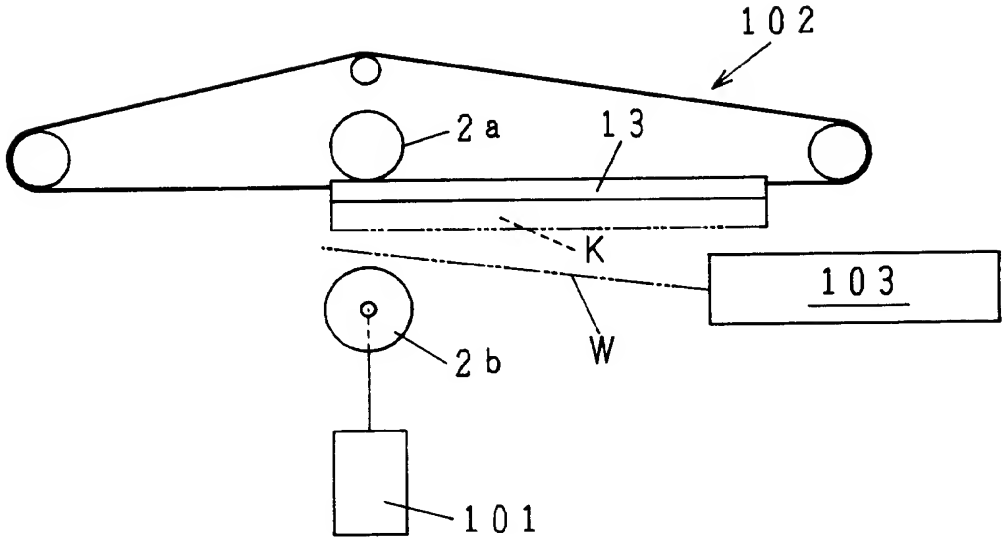


FIG. 4

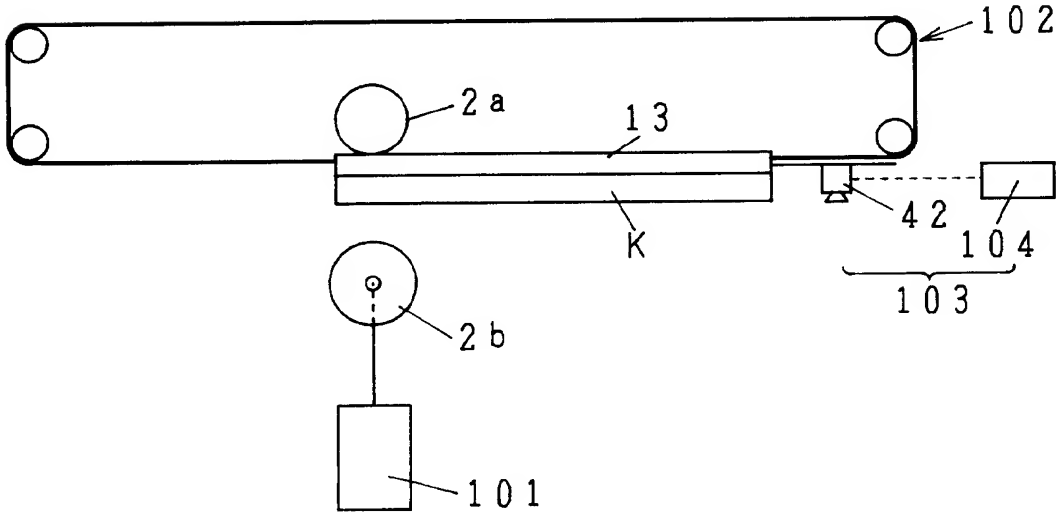


FIG. 5

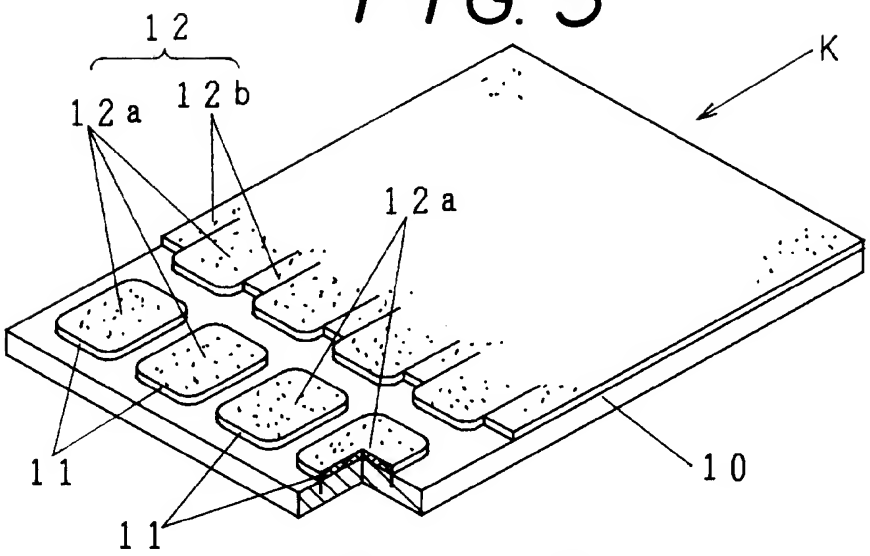

12
12a
12b
K
12a
11
11
10

FIG. 7

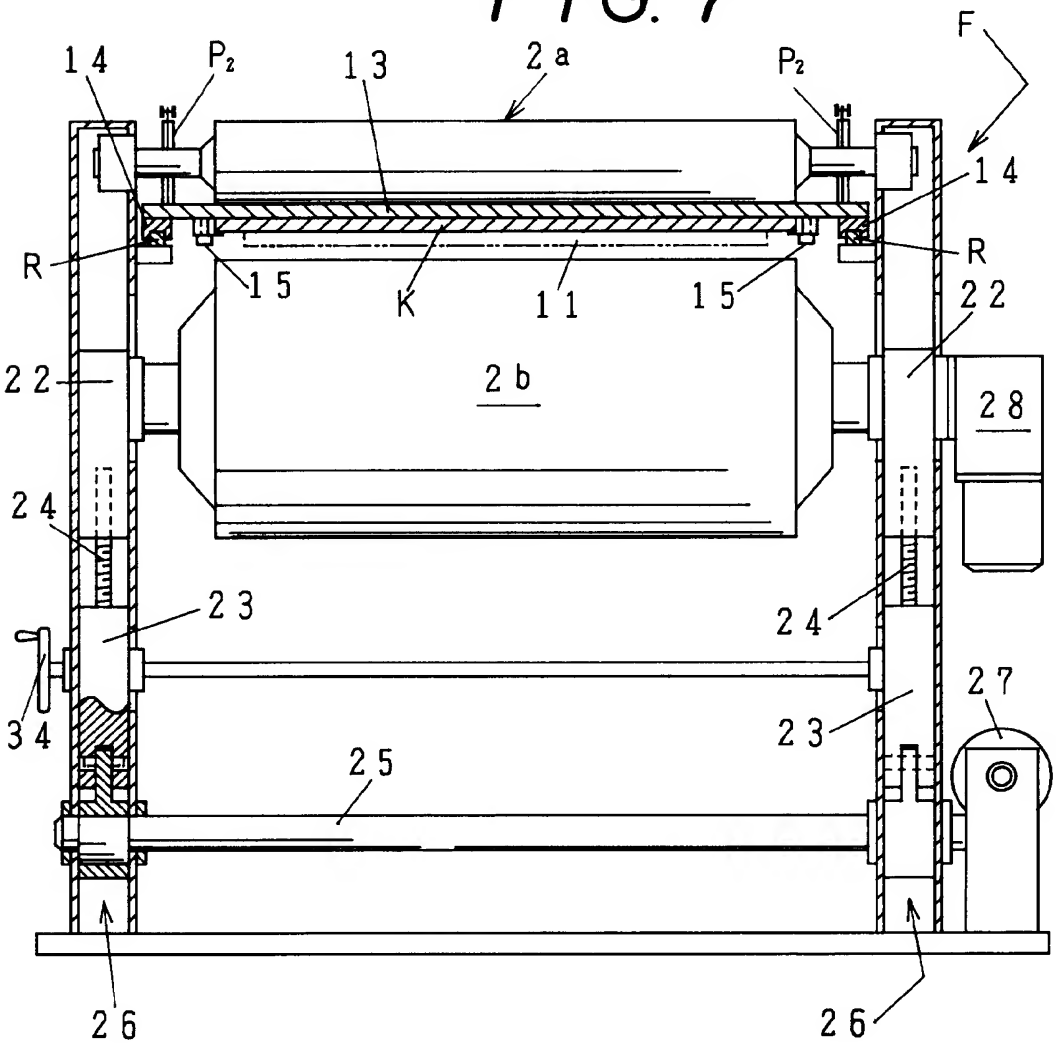

14
P2
13
2a
P2
F
14
R
15
K
11
15
R
22
22
2b
28
24
23
24
27
34
23
25
26
26

FIG. 6

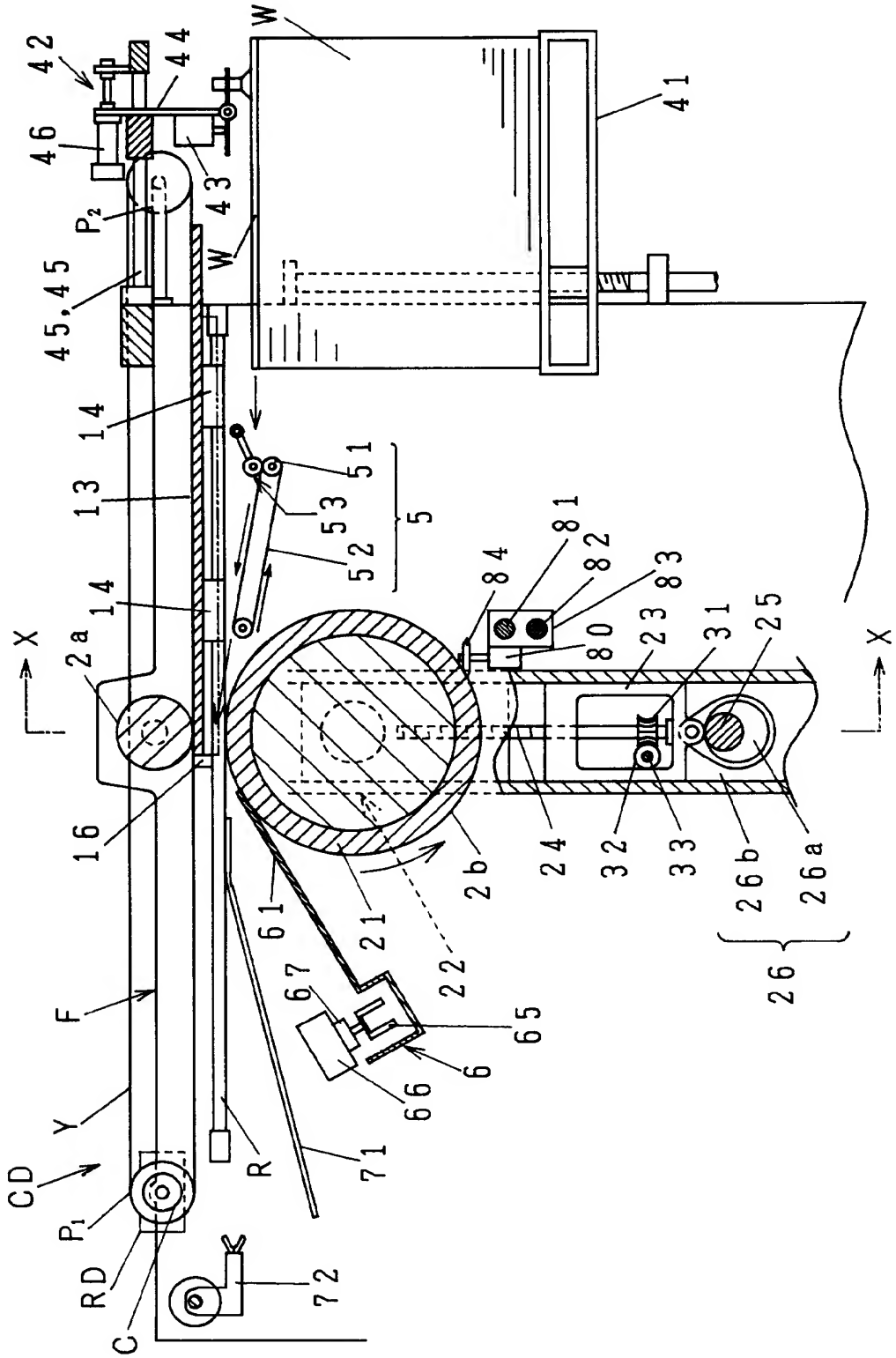

W
41
42
44
46
43
P2
45,45
14
13
51
53
52
5
81
82
83
84
80
23
31
25
X
2a
16
2b
24
32
33
26b
26a
26
61
21
22
67
65
6
66
F
Y
CD
R
71
P1
RD
C
72

FIG. 8

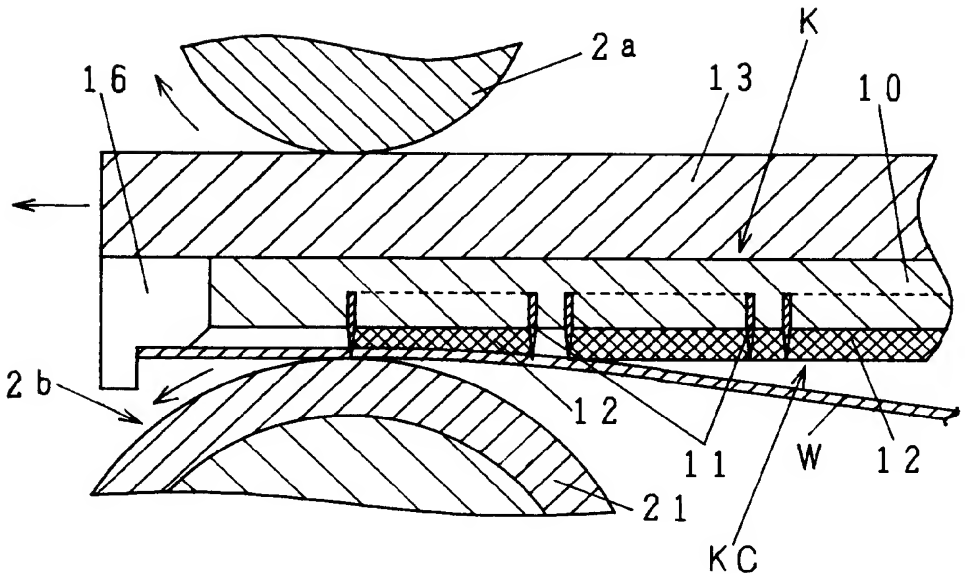


FIG. 9

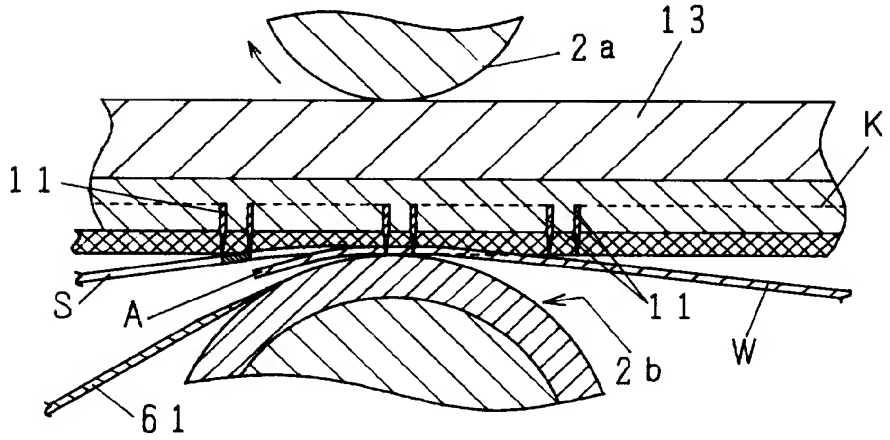


FIG. 10

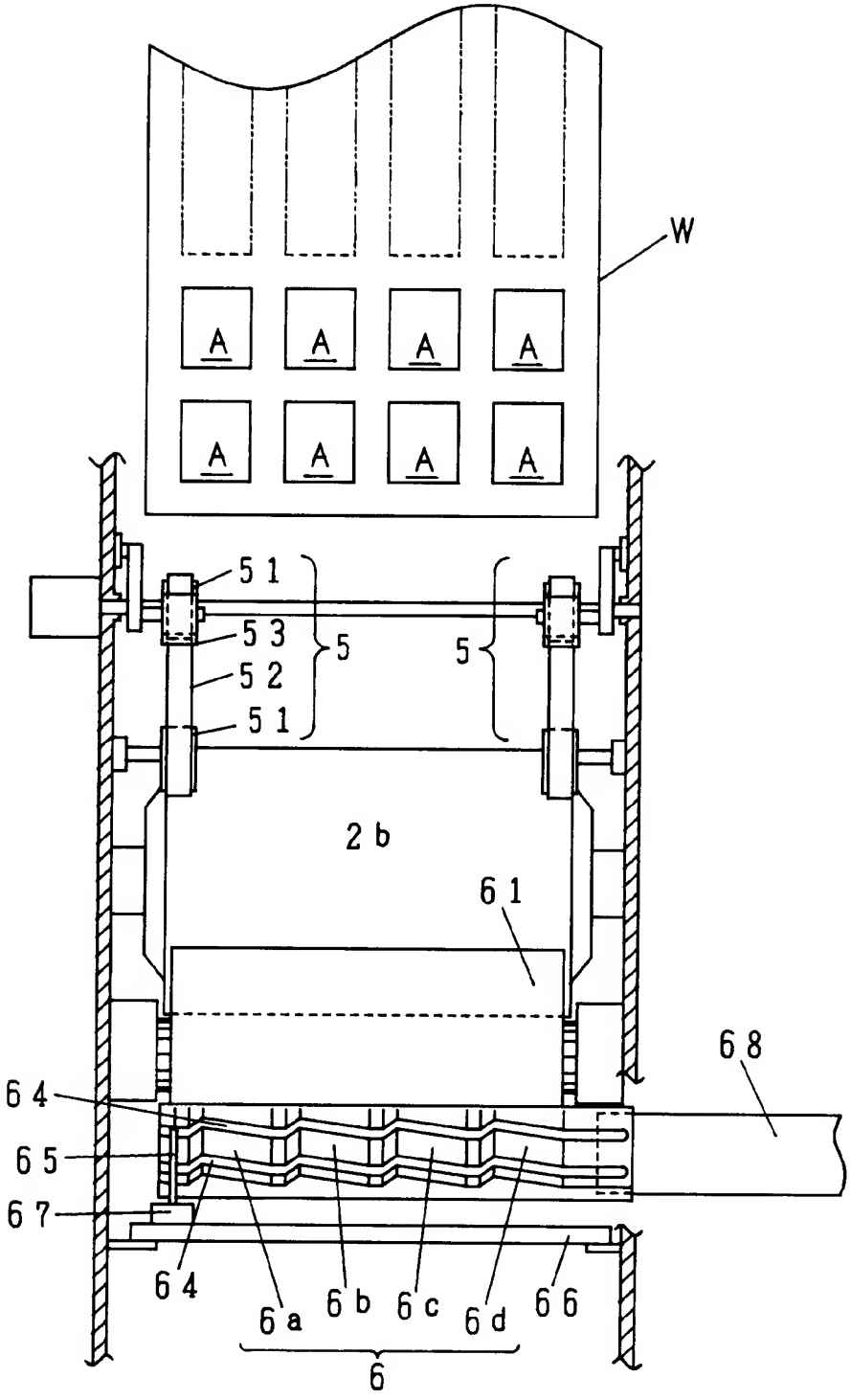


FIG. 11

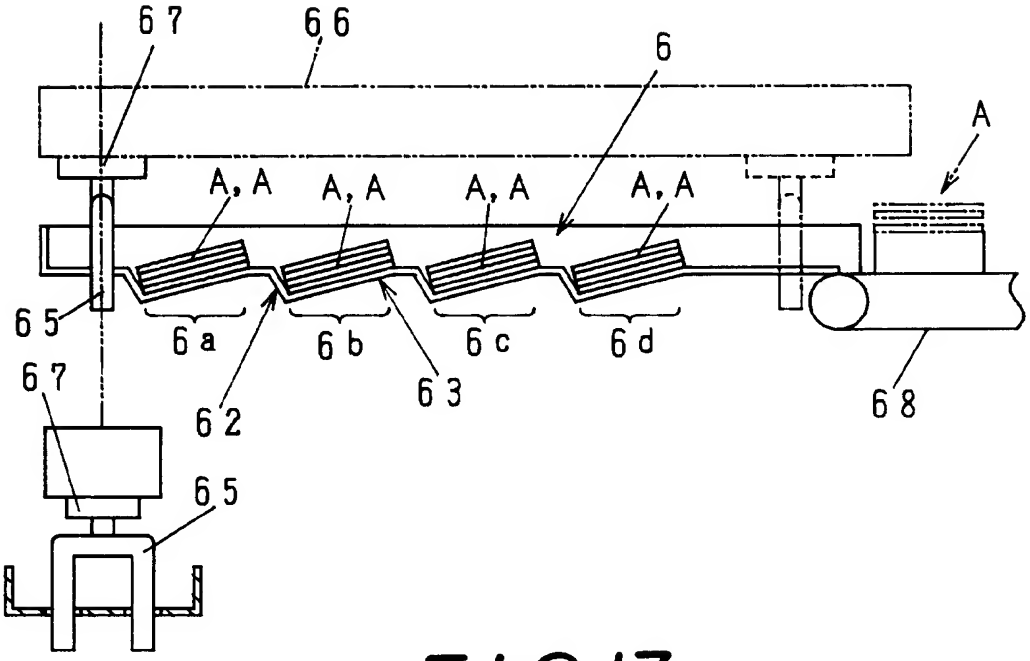

67
66
6
A
A, A
A, A
A, A
A, A
65
6a
6b
6c
6d
67
62
63
68
65

FIG. 13

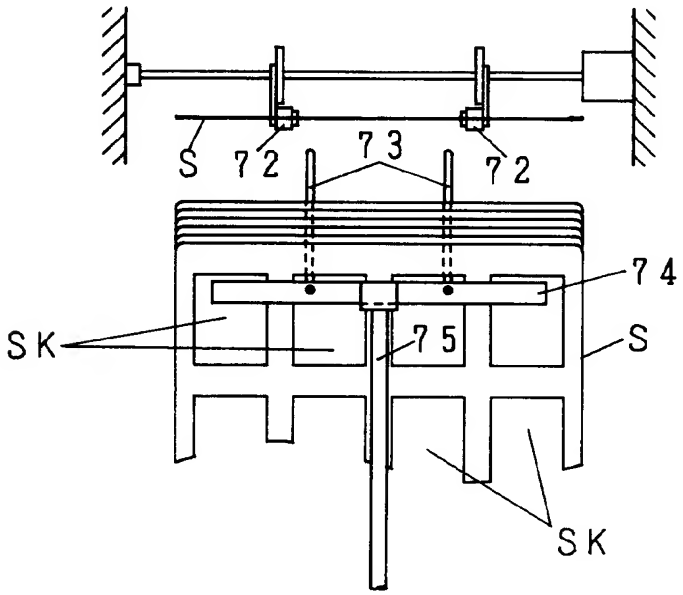

S
72
73
72
74
SK
75
S
SK

FIG.12

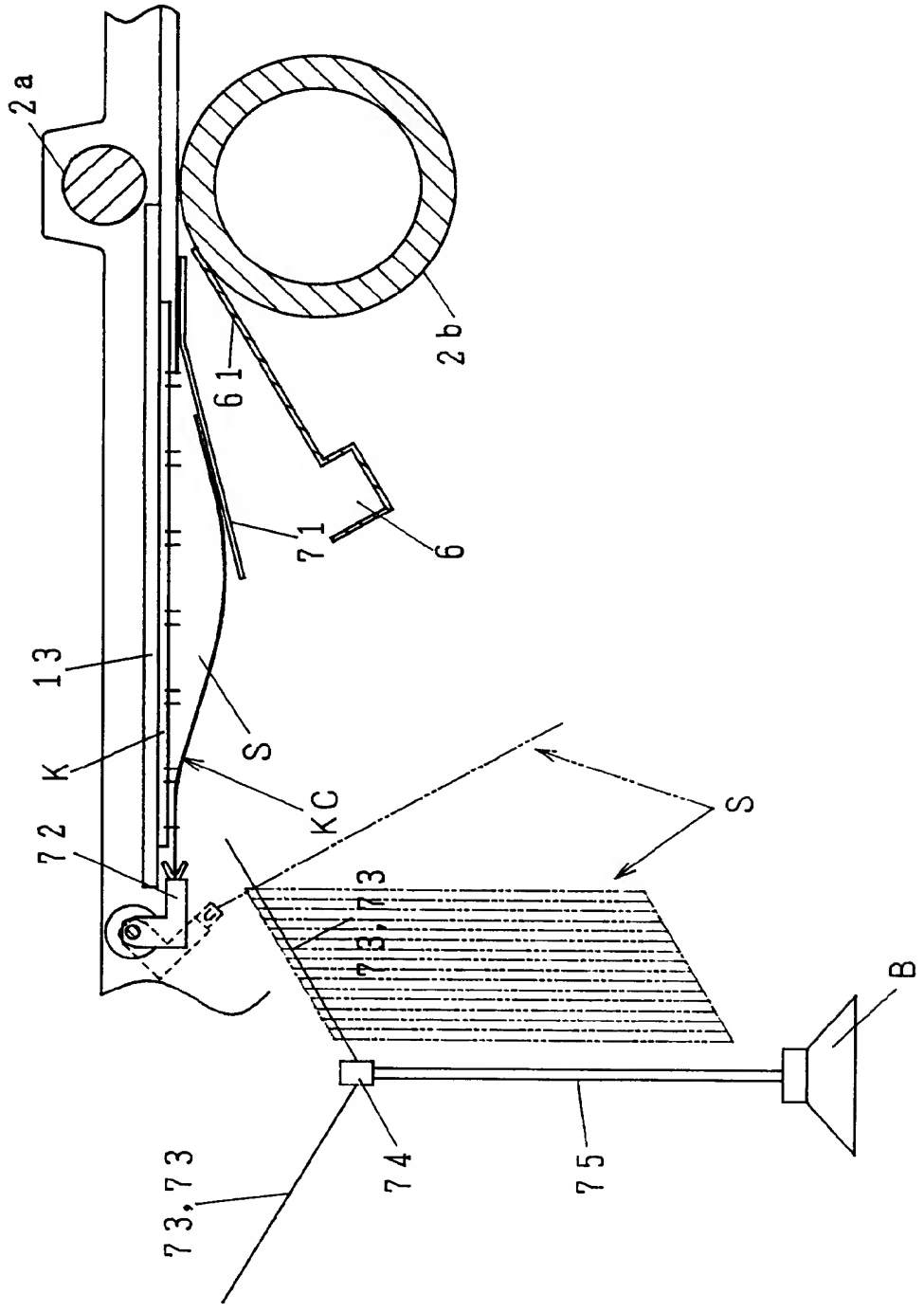


FIG.14

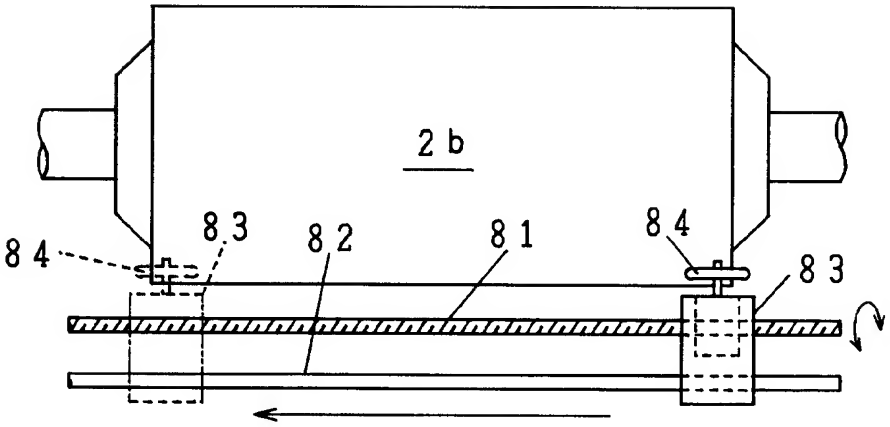
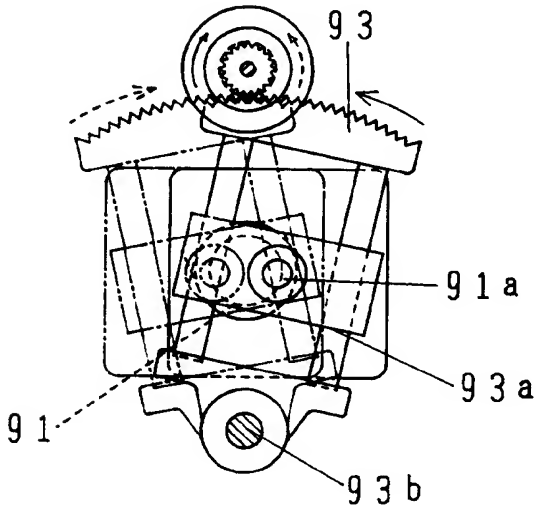


FIG.16



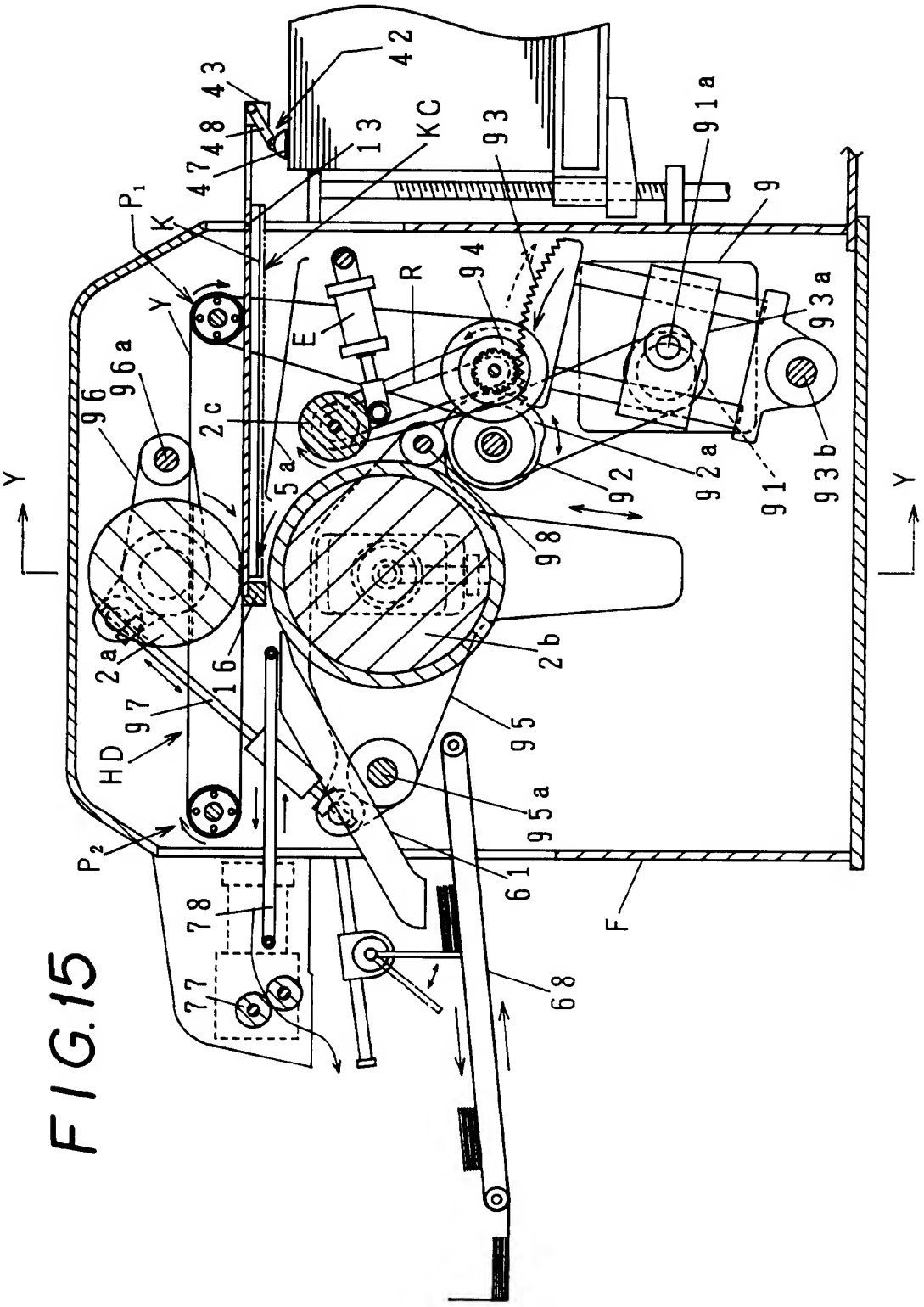

42
43
48
47
13
KC
93
91a
9
P1
K
Y
R
94
E
93a
96a
96
2c
5a
92
92a
91
93b
Y
98
2b
2a
16
97
HD
95
95a
61
P2
78
77
68
F

FIG.15

FIG.17

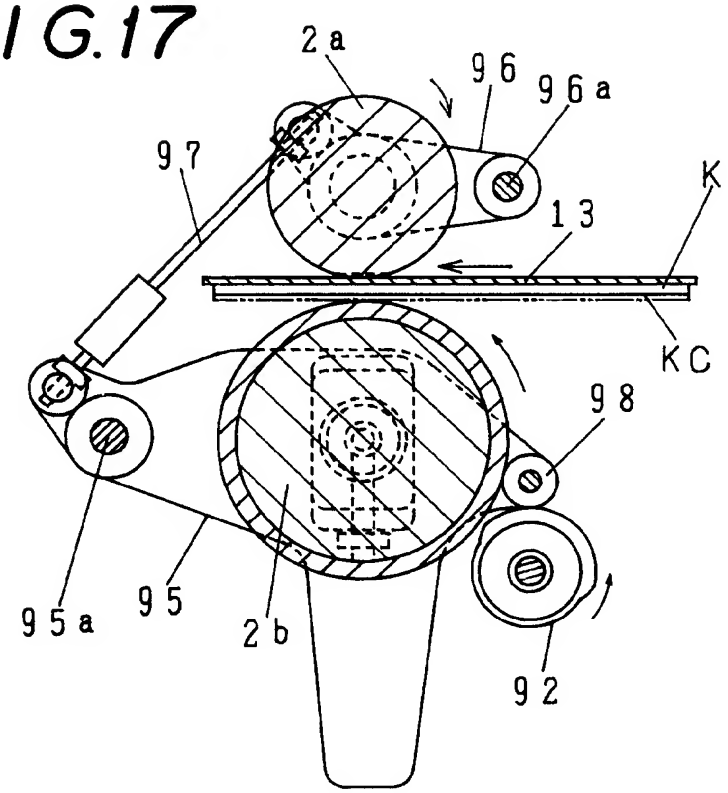


FIG.18

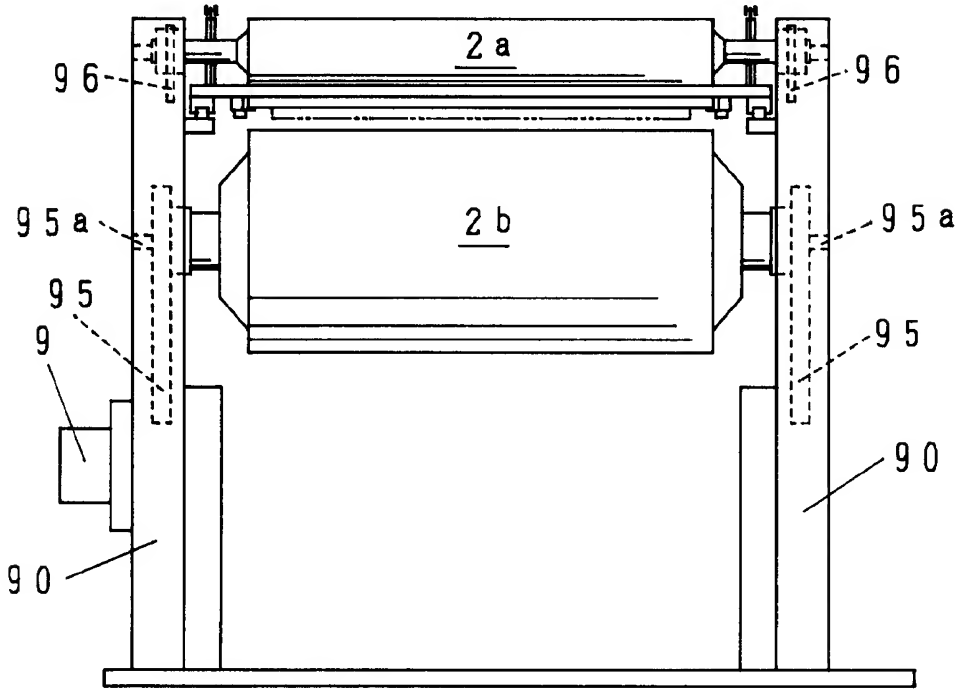


FIG.19

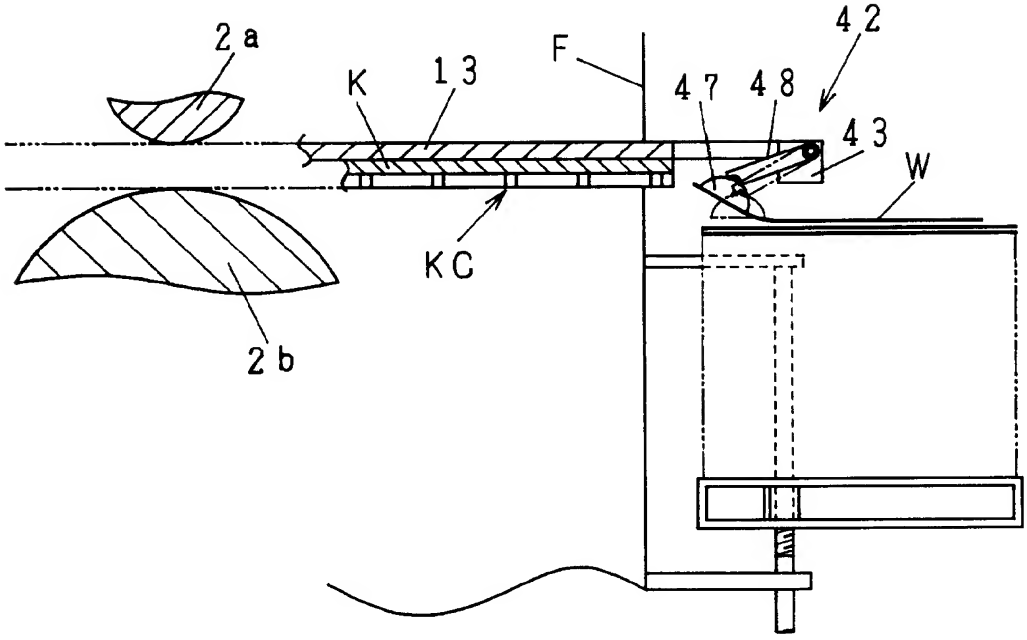


FIG.20

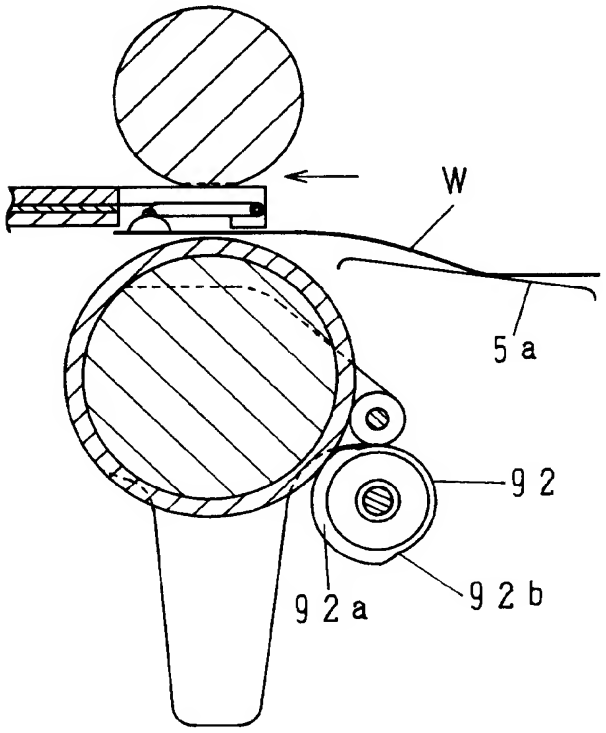


FIG.21

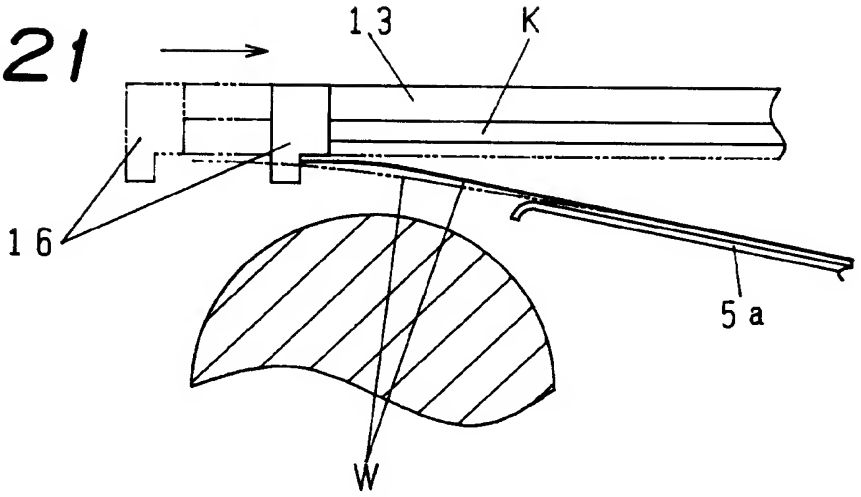


FIG.23

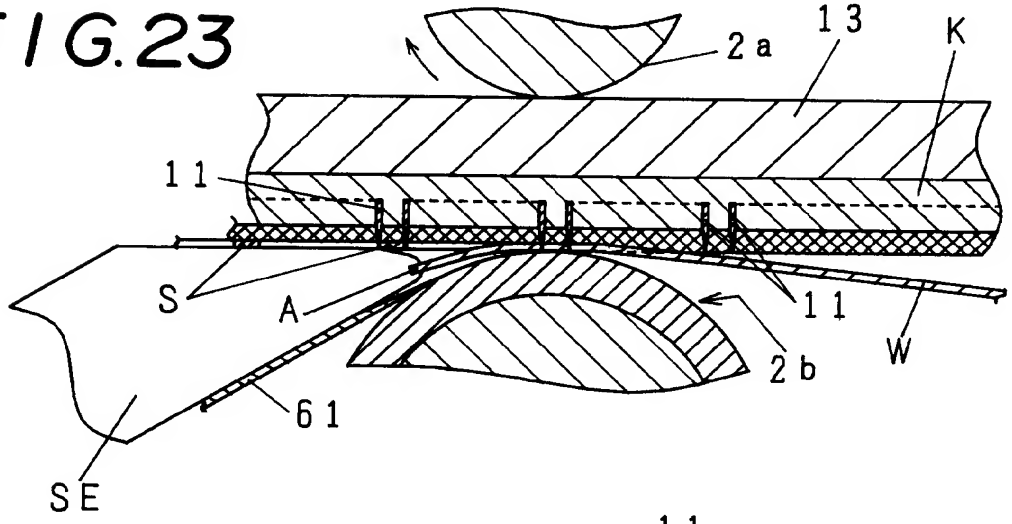


FIG.24

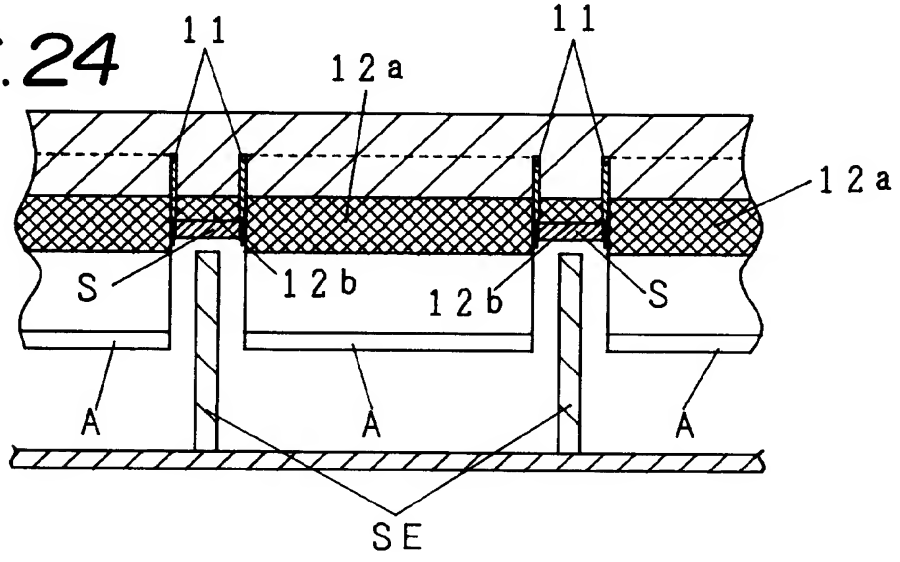


FIG.22

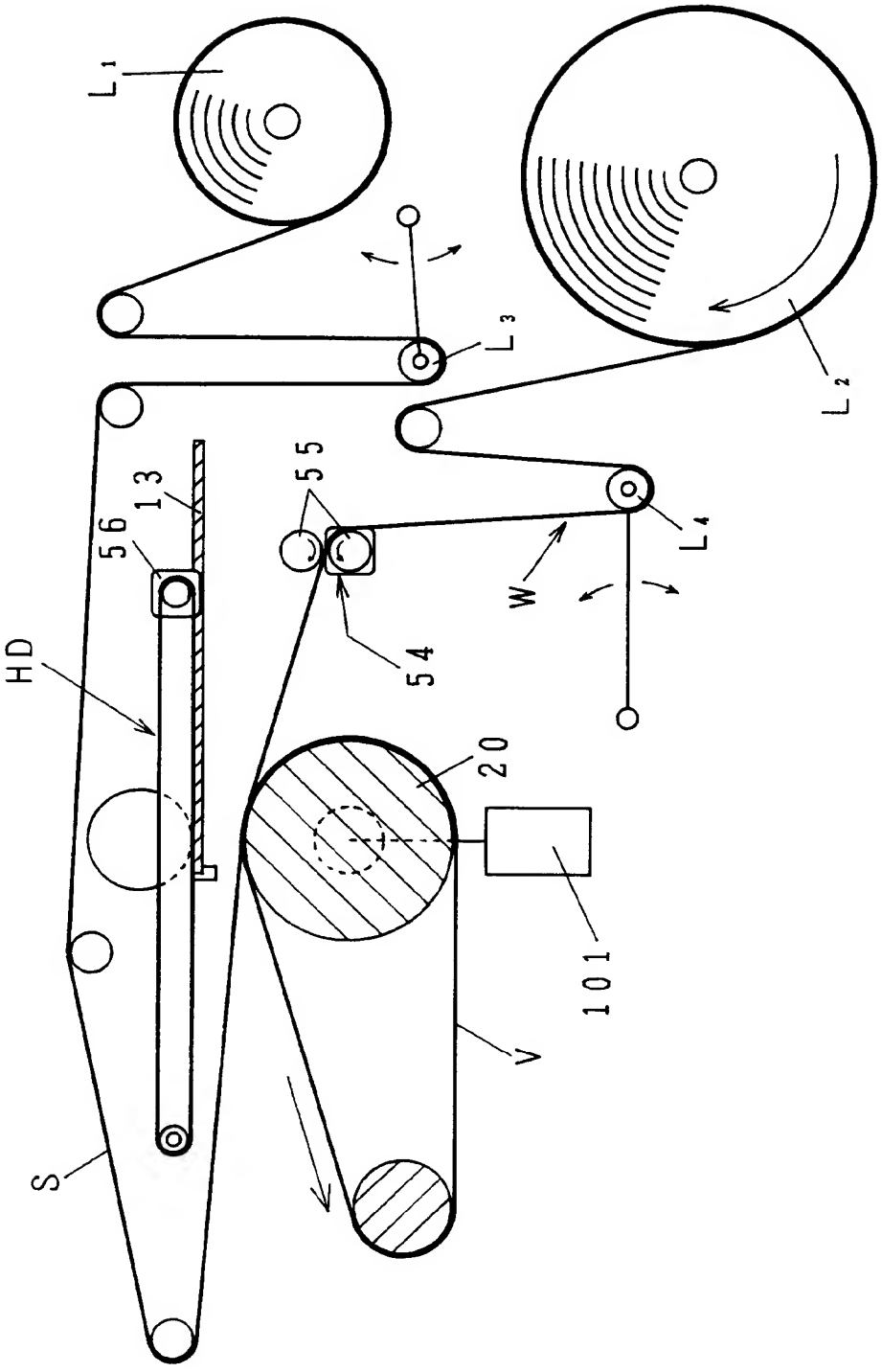


FIG.25

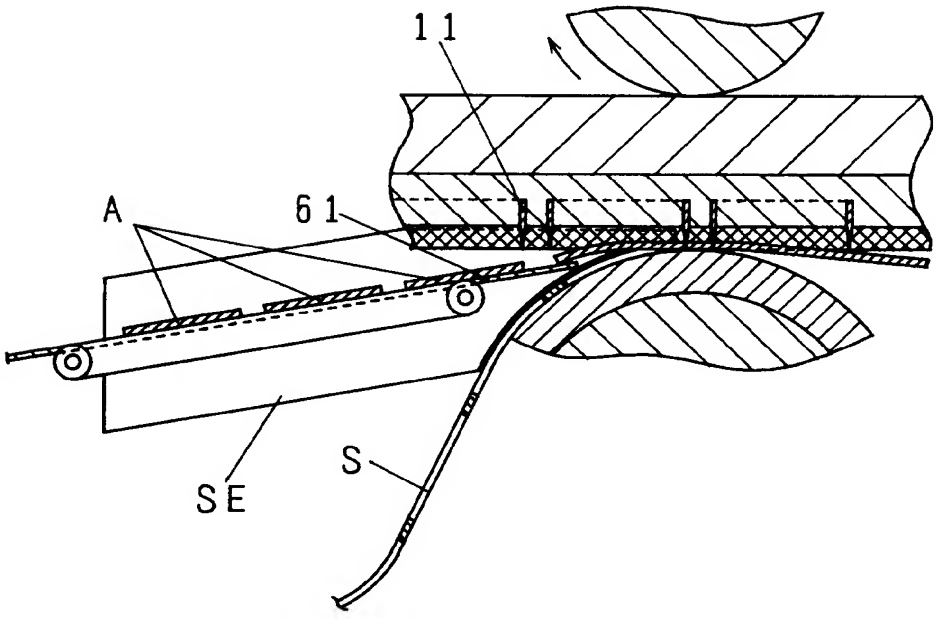


FIG.26

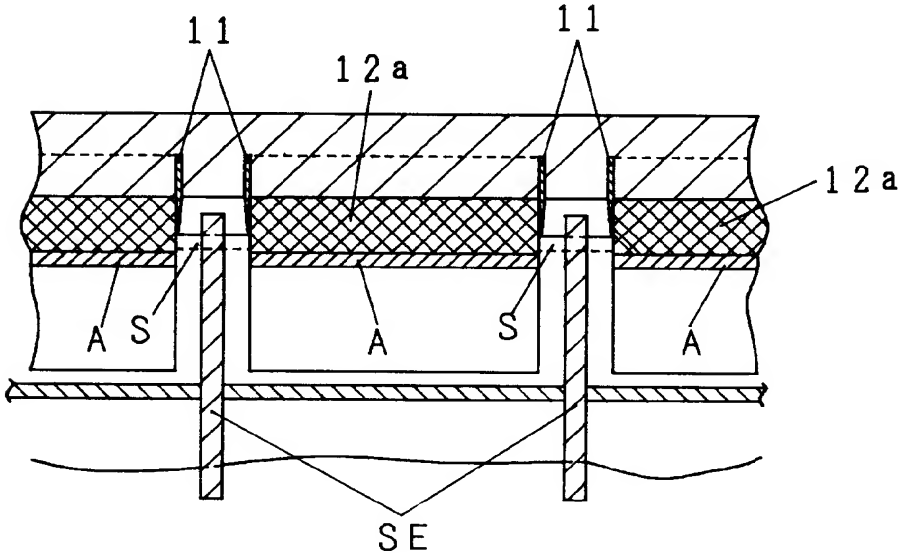


FIG.27

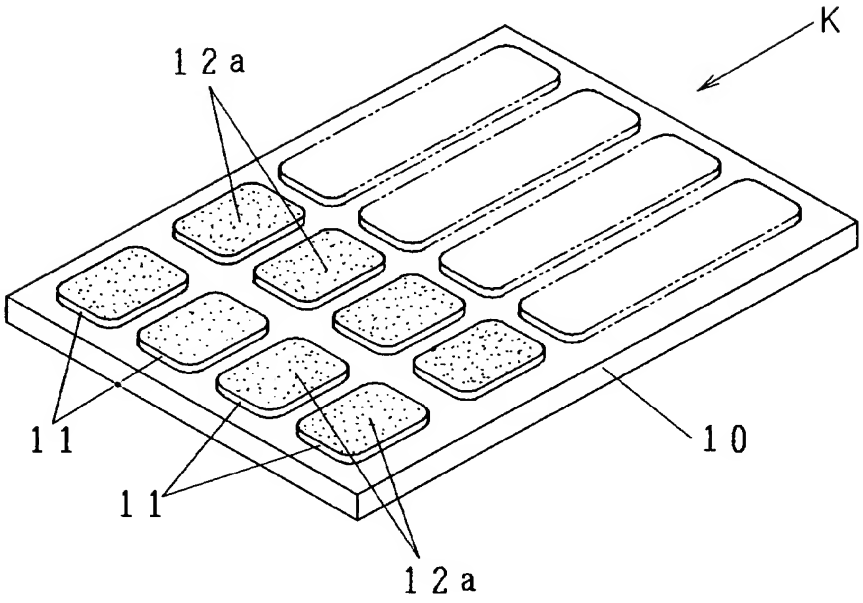


FIG.28